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Results at the Pasadena Activated Sludge Plant

Description of one of the oldest and largest of such plants, its method of operation, and the results obtained during four years. Sludge sold as fertilizer; effluent used on farm land

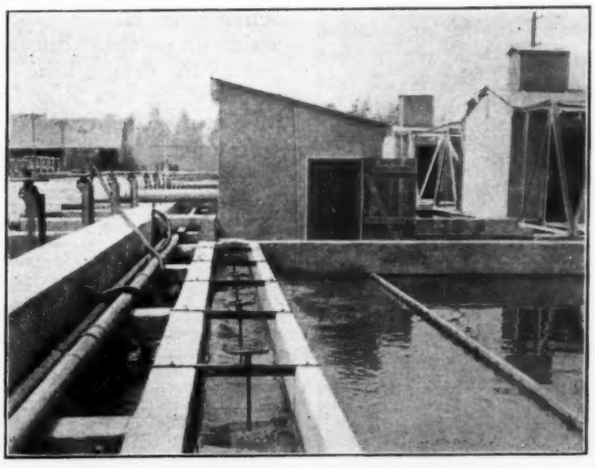
By James N. Hatch

The city of Pasadena, California, in January, 1924 put into operation an activated sludge plant which is therefore one of the older installations in this country. It was designed for a population of 100,000, which was considerably in excess of the population at that time but is now receiving sewage from approximately 120,000, including the towns of Alhambra, South Pasadena, and San Marino. Experience has indicated that the plant will successfully treat 10,000,000 gallons per day without in any way creating any nuisance. The amount received and treated at present is about 7 million gallons per day, with a maximum rate for a few hours at a time of 12 to 14 millions gallons per day. The maximum load is reached during the months of January and February, the height of the tourist season.

The plant is located on the city farm, which is about 5 miles south of the city. It is surrounded with orange groves and flower gardens, eucalyptus and pepper trees, and it is said that these conceal not only the appearance of the plant but also any odors arising from it.

The sewage reaches the plant through a 30-inch sewer capable of delivering about 38 million gallons per day. It is pure domestic sewage, including practically no ground water. It first passes through a Dorrco screen 8 feet diameter and 8 feet long with 2-inch by $\frac{1}{16}$-inch slotted holes. The original Dorrco screen was 6 feet by 6 feet with $\frac{1}{8}$-inch holes, but this is used now only as a standby. The screenings, which are elevated in the regulation bucket elevator from the screenings pit and discharged by it into a hopper, are withdrawn from the hopper into motor trucks and hauled away to be buried on the farm. They amount to about 30 cubic feet per million gallons of sewage, or about 10% of the total solids in the sewage. They can be handled with a pitchfork, but contain about 88% moisture. It was proposed later to dry the screenings and use them for the manufacture of commercial fertilizer.

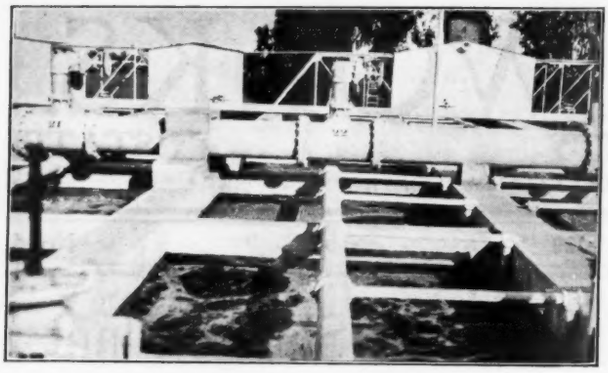
The effluent from the screen flows to the aeration tanks through a concrete trough 5 feet wide by 8 feet deep, which runs the entire length of the row of tanks. These tanks comprize, first, two dosing tanks; then five re-aeration tanks, then thirty aeration tanks. The dosing tanks are 15 feet wide by 40 feet long by 12 feet deep; the aeration and re-aeration tanks are 67½ feet long, 10 feet wide, and 15 feet deep. The effluent trough discharges into each of the aeration tanks through a 12-inch by 12-inch gate; which gates are always open except when an individual tank must be shut off for any purpose. There are also gates opening from the re-aeration tanks to the effluent trough, and about 25% of the activated sludge is returned to the trough to mix with the screen effluent and pass again through the aeration tanks.



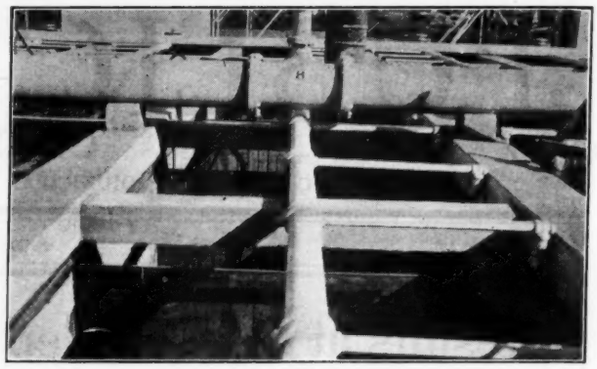
CLARIFYING TANKS, EFFLUENT CHANNEL AND SLUDGE PUMP HOUSES

The mixture of screen effluent and re-aerated activated sludge in the aeration tanks is agitated by means of diffused air through porous plates. Each tank is divided by wooden baffle walls into seven compartments, connected by a continuous passage for the sludge along the bottom; the purpose of the baffles being to prevent short circuiting in the tank and assist in thorough mixing. The sewage remains in the aeration tanks about four to six hours, and then overflows into a trough that passes along the outlet ends of the tanks and carries the effluent to five clarifiers.

The clarifiers are 50 feet square and 12 feet 4



AERATION TANK BEING AGITATED BY COMPRESSED AIR
Shows compressed air pipes. Houses in background contain sludge pumps.

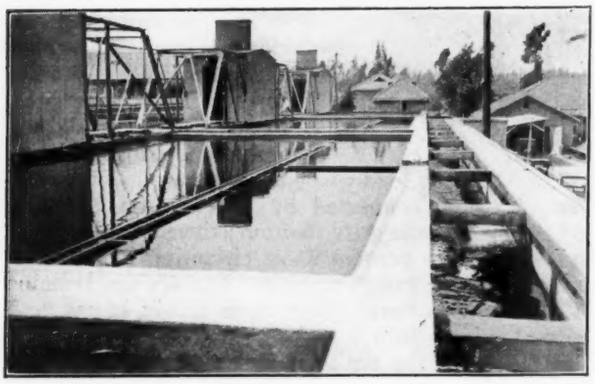


AERATION TANK WITH SEWAGE DRAWN OFF, SHOWING WOODEN BAFFLE WALLS

inches to 16 feet deep. They are sedimentation tanks, the circular bottoms of which are equipped with a scraping device operated by a variable-speed motor which moves the scraper at the rate of about one revolution in 20 or 30 minutes. Three of the tanks are fitted with rake scrapers and two with Hardinge spiral scrapers. The purpose of the scrapers is to keep the sludge from solidifying in the bottom of the tank but without agitating it so much as to cause it to rise to the top. The sludge is removed from the clarifying tanks by means of De Laval centrifugal pumps, one of which is provided for each tank, which pump it into the re-aeration tanks. The pumps are operated at such speed as to keep the settled sludge in the clarifiers at a constant level, drawing the most condensed sludge continuously from the bottom of the hopper. The effluent from the clarifiers is dosed with about 25 pounds of chlorine per million gallons.

The liquid sludge is re-aerated in the re-aeration tanks by means of compressed air. That which does not flow into the sludge trough is discharged into one of the two dosing tanks each holding 40,000 gallons. In the dosing tanks the sludge is dosed with 10 to 14 pounds of alum and 7 to 14 pounds of Filter Cel per thousand gallons, and re-aerated for 4½ hours, when it is drawn off to the filters. The Filter Cel is an inert earthy material which is found to reduce the moisture content of the sludge from the 77 to 82% obtained by the use of alum alone, to 82 to 87%.

After being treated in the dosing tank, the sludge



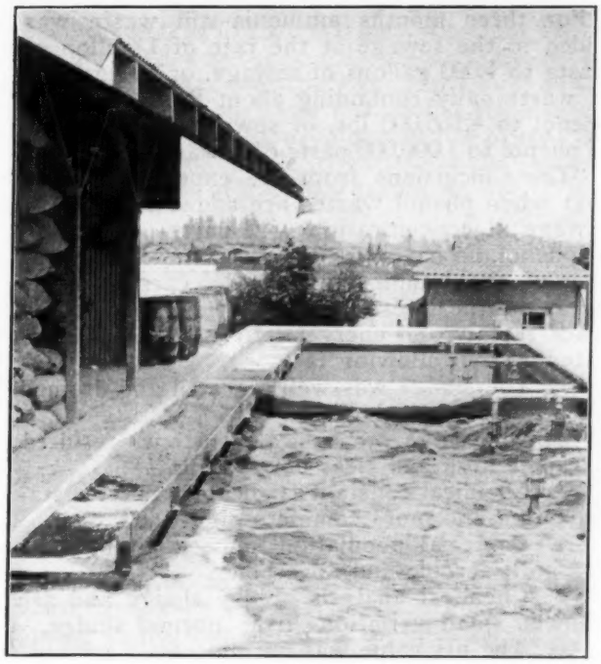
CLARIFYING TANK, OVERFLOWING TO EFFLUENT CHANNEL AT RIGHT

is carried by gravity to the filter house and is dewatered there in three Oliver Filters, 11 feet 6 inches diameter and 14 feet long, revolved very slowly by a 5 h.p. motor. These filters are covered with heavy wool cloth held on by wire bands spaced two inches apart. The part of the filter which is submerged in the sludge (about 3 feet depth) is under a vaccum of 21 to 25 inches. The cake which forms on the outside of the cloth is scraped off by a thin steel plate, aided by internal air pressure. It is of dark color and looks very much like heavy blotting paper and has no disagreeable odor. This cake falls onto a belt conveyor by which it is carried up and discharged onto a cross-conveyor which carries it to the dryer house. Immediately over the conveyor and nearly touching it are a number of sharp-edged revolving discs on horizontal transverse shafts so arranged in a staggered position as to cut the cake, as it passes along, into small bits so as to be more readily handled in the dryer. The cross-conveyor delivers the bits of cake onto another belt conveyor which drops them into a feed hopper over the feed end of the drying kiln.

The dryer is a Ruggles-Coles type revolving kiln, the outer shell of which is 70 inches diameter by 60 feet long. Inside this cylinder is another circular shell 30 inches diameter, concentric with the outer shell and fastened to it. The cake to be dried is fed into the upper end of the annular space between the two shells where, owing to the slope at which the kiln is set, it gradually works its way through the kiln and is discharged at the lower end. Heat from burning natural gas is blown into the inner cylinder at a temperature of about 2,000 degrees and is carried through this to the lower end of the kiln and returns again to the upper end of the kiln through the annular space, thus passing through the cake.

The dried cake leaves the kiln in the form of a clinker, which drops into a bucket elevator, which carries it to an overhead screen. The material which will not pass through the screen is returned by a screw conveyor to the feed hopper and again passes through the dryer. That which passes through the screen then goes to a crusher and is ground up fine and fed to a packing chute, which feeds it into 100-pound sacks which, when filled, are placed in the warehouse for sale as fertilizer. At present the output of fertilizer is about 8 tons per day, all of which finds a ready sale at $25.25 per ton at the warehouse.

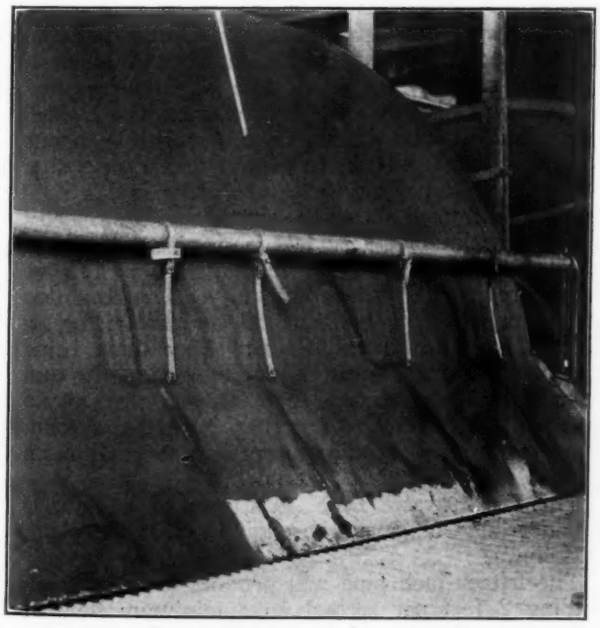
At first the air and steam from the dryer was



DOSING TANKS, WHERE ALUM AND "FILTER-CEL" ARE INTRODUCED

discharged into the atmosphere, but there were continual complaints from the nearby residence district of disagreeable odors. Recently a super-heater was added to the drying plant which has overcome this objection. In this superheater the vapor is passed over and under a succession of highly heated baffle walls, where the solids contained in the vapor are destroyed by heat, the super-heated steam being carried off by a chimney. There have been no further causes of complaint from this source.

The clarified and chlorinated effluent is used for irrigation on the farm or is discharged through a 36 inch pipe line four miles long into the Rio Hondo.

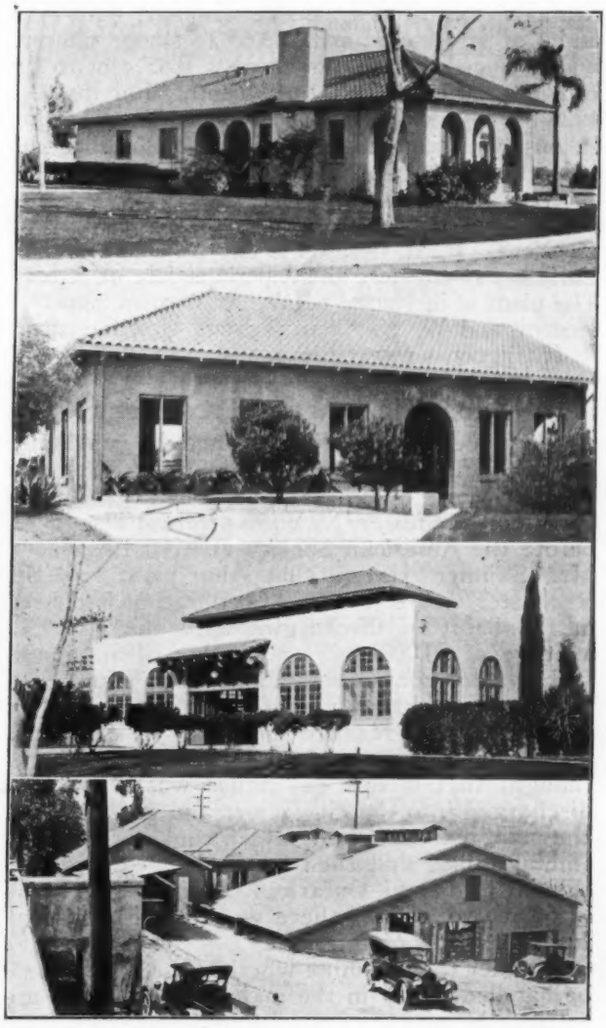


ONE END OF OLIVER FILTER, SHOWING STEEL PLATE SCRAPING OFF CAKE OF DEWATERED SLUDGE

The irrigation season on the farm is from May to November, and during this time about one half of the effluent is used for irrigation. It is expected that the remaining part of the effluent will eventually be sold to private companies for irrigation purposes. When this is done and when the orchards on the farm are in full bearing, it is believed that the income from these and from the sale of fertilizer will show a profit to the city from the operation of the plant.

The farm consists of about 576 acres, three-fourths of which is suitable for farming. There is an orange and grapefruit orchard of 60 acres, a walnut orchard of 30 acres, and other miscellaneous fruits are grown, as are also beans, potatoes, alfalfa, etc. The farm was purchased by the city in 1886 for $36,000 and was used at first for disposing of sewage entirely by irrigation. It is said that an offer has been made for the farm of about two and a half million dollars.

The dried fertilizer, which contains less than 4% moisture, is in good demand and can all be disposed of locally. It is marketed under the name of "nitro-



TOP—OFFICE AND LABORATORY BUILDING

NEXT—BUILDING WHERE RAW SEWAGE IS RECEIVED AND SCREENED

NEXT—BLOWER BUILDING

BOTTOM—STORE ROOMS FOR FERTILIZER. FILTER HOUSE AND DRYER HOUSE IN BACKGROUND

ganic fertilizer" and shows the following analysis:

Nitrogen total 5.0%.
Nitrogen as ammonia (calculated) 6.07%.
Phosphoric acid, available, 2.0%.
Phosphoric acid, total, 2.4%.
Potash, 0.3%.
Organic matter, 65.0%.

The compressed air for the aeration and re-aeration tanks is furnished by five blowers located in a blower house, which furnish seventeen to eighteen million cubic feet of air per day under a pressure of 9.5 pounds per square inch. The vacuum for the Oliver filters is furnished by three dry vacuum pumps, two furnished by the Oliver Company and the third an Ingersoll-Rand machine. All power used in purchased from the Southern California Edison Company through transformers at the plant. The connected load totals 1,400 h.p.

The force at the sewage disposal plant totals 28 men. During the year ending June 30, 1927, a total of 1,987 million gallons of sewage was treated at a cost of operation of $67.98 per million gallons. Of this total charge, $37.56 is allocated to sewage treatment exclusive of sludge disposal; $16.77 to burial of screenings; and $13.65 to sludge filtering and drying. Electric power costs 0.85 cent to 0.9 cent per k.w.h. or $3,100 per month. For the year 1928 the cost of operation was about $73 per million gallons, with a revenue from sale of fertilizer of $13 per million gallon. It is expected that the present year will show a larger revenue.

The plant is owned and operated by the city of Pasadena. R. V. Orbison is city manager. W. C. Earle is city engineer and superintendent of streets. The plant is in charge of W. A. Wyman, superintendent, and W. A. Allen, assistant superintendent. L. H. Bigger is research engineer.

Phenol in Sewage Treatment

The effect of phenol contained in gas house waste upon the operation of an Imhoff tank was described by John F. Skinner, deputy city engineer of Rochester, N. Y., in a recent discussion before the American Society of Civil Engineers. Mr. Skinner stated that the plant of the Rochester Gas & Electric Corporation had been in the habit of discharging into the river an average of 20,000 gallons per day of ammonia-still waste containing about 350 pounds of phenol, and that under certain conditions of wind this waste reached the water works intake and resulted in complaints of taste. It was thought that if this gas house waste could be discharged into the city sewer and pass through the main disposal plant, which consists chiefly of Imhoff tanks, and then be discharged with the effluent into Lake Ontario, 7,000 feet from shore in 50 feet of water, there would be little if any future trouble of this kind.

In order to determine whether the waste could be handled safely in the main plant without upsetting the action of the Imhoff tanks and their ability to digest sludge properly, a large-scale experiment was conducted at a small city plant where the discharge averages 500,000 gallons daily, the Imhoff tank of which had an inside diameter of 38 feet and a semi-circumferential sewage flow.

For three months ammonia-still waste was added to the sewage at the rate of 1 gallon of waste to 1,000 gallons of sewage, or 500 gallons of waste daily containing about 8.75 pounds of phenol to 4,166,000 lbs. of sewage; or 2.1 parts of phenol to 1,000,000 parts of sewage by weight.

"The conclusions from the experiment were that when phenol wastes are added to sanitary sewage at concentration of 2 parts per million of phenol, no harmful effects result. The operation of the Imhoff tank can be carried on as usual and the digestion of the sewage solids takes place rapidly and energetically. This was indicated by the following facts:

"1. The sludge was well digested and drained quickly on the drying bed.

"2. No change in physical constants resulted except a high and clear dewatering.

"3. Chemical constants indicated a better stabilization and more complete digestion.

"4. Bacterial population showed an increase for both aerobic and anaerobic.

"5. Chemical analysis of dry sludge and ash showed small variations from normal sludge.

"6. The pH value was normal.

"7. A high rate of gas, which was about 70% methane and 30% carbon dioxide, resulted, with a calorific value of 700 B.t.u."

As a result of these experiments, the plan was put into operation of discharging the gas company's waste into the main sewer and "no upsetting of the plant has occurred, and all complaints of taste in the water have ceased."

Some Sewerage Details at San Bernardino

San Bernardino for the past year has been constructing a sewage treatment plant one and a quarter miles south of the city in the low, swampy flood plain of Warm Creek, which is about fifty feet lower than the southerly city limits, consisting of Imhoff tanks and trickling filters. It was necessary to cross the creek between the city limits and the outlet at the proposed plant by means of either a trestle or siphon. As the former might be washed out and would be the more expensive, it was decided to use an inverted siphon, which would be about 6,350 feet long from the city limits to the plant site. It was considered desirable, in order to prevent deposits in it, to so design the siphon that the velocity would be maintained at no less than 2 feet per second at all times, whatever the fluctuations in flow or the future growth of the community. This condition was secured by constructing three separate lines, a 15-inch, an 18-inch and 24-inch line; these being so controlled at the lower end by Venturi meters and automatic motor-operated gate valves, that at no time will the velocity be less than 2 feet per second, or so great as to require more than the maximum allowable head.

This is illustrated by S. S. Currie of the Currie Engineering Company, the engineers for the plant, as follows:

The fifteen-inch pipe will produce a velocity exceeding 2 feet per second on a minimum flow of 1,500,000 gallons per day, which, according to gaugings made throughout the summer of 1927, exceeded the minimum flow. The fifteen-inch line will handle

a maximum flow of 2,200,000 gallons per day before backing the sewage up in the main outfall sewer in the city. At such time as the maximum capacity of the 15-inch pipe is reached, the 18-inch pipe automatically will be opened and the 15-inch will be closed; the 18-inch producing a velocity exceeding two feet per second on a flow of 2,200,000 gallons per day. When the 18-inch line reaches its capacity of approximately 3,500,000 gallons per day, the 15-inch will be opened and the two operated together will produce a minimum velocity of 2 feet per second for a discharge of 3,500,000 gallons per day. The maximum capacity of the two lines is 5,700,000 gallons per day. In the same manner, at the time the 15-inch and 18-inch lines have reached their combined capacity, automatically they will be shut off and the 24-inch turned on. Also, as the flow decreases, the larger lines automatically will be cut off and the smaller ones turned on. The siphons are so constructed that any one or all of them can be completely drained. The sewage rises vertically to the plant through a chimney at the end of the siphon, at the top of which the sewage flow is split into two equal parts, flowing to two identical units of the plant.

An interesting feature of the plant is that the interior of the tanks and dosing chambers will be waterproofed with two coats of biturine; and all exterior surfaces will be covered with a half-inch gunite finish of natural cement color. All walks will be provided with galvanized iron railings and will be steel trowelled to a smooth finish to provide easy cleaning. The roof of the control house will consist of red tile, and the tops of the walls surrounding the trickling filter beds will be provided with a red tile trim. Plans contemplate the grading, seeding and landscaping of the forty acres surrounding the plant, and the entire tract will be enclosed with a seven-foot non-climable fence with an ornamental wrought iron gate.

All gas outlets will be tightly sealed with concrete covers and provided with gas collecting domes, and the gas so collected will be used for operating a gas engine and electric generator, while that not so used will be burned to eliminate odors. Odors emanating from the spraying of the sewage will be controlled by chlorine, applied either at the front end of the siphon line, at the inlet to the Imhoff tank, or at the inlet to the dosing chambers. To prevent odors from solids which may float upon the flowing-through chambers of the Imhoff tanks, these will be kept free from floating solids through the use of mechanical skimmers. Overhead carriers are provided to facilitate the removal of sludge from the sludge beds.

Report on Activated Sludge Plants

Abstract of report of committee of New York Board of Estimate on its findings relative to ten activated sludge plants. Discussion of screening, sedimentation tanks, and the various features of activated sludge operation

In the issue of PUBLIC WORKS for May, 1928, under the above heading, we published the preliminary condensed report on activated sludge plants given out by a committee of the Board of Estimate & Apportionment of New York City, preliminary to a more complete report of the committee. This complete report has now been published, and its finding concerning the ten activated sludge plants examined will be of interest to sanitary engineers. Excerpts and abstracts of parts of this report are given below:

In its general introduction to the report the committee stated, referring to the matter of nuisances at activated sludge plants: "From our observations it would appear that no odors or objectionable conditions developed up to the point of the disposal of the sludge. The lagooning process is attended with the development of odors which vary in offensiveness with the condition of the lagoon, while the sludge drying beds seem to be inoffensive. The plants used for the manufacture of fertilizer are probably responsible for a marshy or coffee odor, which is not seriously offensive, and which apparently is or can be kept under such control that the plant can not be charged with conditions any more objectionable than usually occur in manufacturing plants. In some of the plants of the latter character, some trouble has been experienced by reason of the development of fire in the dryer, but this is believed to be wholly a matter of proper operation."

SCREENING

Coarse screens are generally placed in front of pumps, fine screens, or other devices requiring protection from large floating material that might cause injury. The usual form is the inclined rack of parallel bars, spaced up to five inches apart and cleaned by hand, but in large installations some mechanical equipment is desirable. At three of the plants inspected, cage screens were found in pairs, used alternately; they are adapted to large flows and deep sewers, where the limited amount of manual labor required is justified. At two of the plants the Dorrco coarse screen was used.

Fine screens of the Riensch Wurl type are in use at one of the Chicago plants, of the Tark or Link-Belt type at Milwaukee; of the Dorrco type at four California plants; and of the Hurd type in Indianapolis. Five of these furnish preliminary treatment for the activated sludge process, while the function at two is to protect bathing beaches. In general, the trend seems to be in favor of slotted plates rather than wire mesh.

There are so many factors upon which screen performance depends that comparisons are difficult. Tests, unless made in parallel on the same sewage, are liable to be grossly misleading and it is a question whether there is a material difference in efficiency in the above standard types of screen. If a fine screen is considered preparatory to activation, the choice of fineness will depend somewhat on

whether the sludge is to be made into fertilizer, in which case it may be desirable to permit more solids to pass through in order to increase the marketable product, but the cost of aeration will probably be greater. If the screen is for the protection of the waterfront, the end to be sought is the removal of solids offensive to sight, and for this any one of the above screens operating with a slot 1/16 inch wide will serve the purpose.

While, as stated, individual tests vary greatly, an average removal of about 10% of the suspended solids may generally be expected, but whether this is 5% or 15%, the main object of screening has been accomplished unless further protection by chlorination is necessary, in which case a high removal of solids to reduce the cost of chlorine may be desirable.

In choosing a fine screen it would seem that too much stress has been laid in the past on efficiency as shown by short tests. Reliability of performance, durability, first cost and upkeep are believed to be matters of much more importance, and concerning these information is gradually accumulating with longer experience.

The disposal of screenings by burying in small quantities and in rural areas is often the simplest and best method. Where the volume is large or where the plant is in urban territory, the problem is more difficult and a choice must be made of several possible procedures. The screenings from the New York plants at Canal street and Dyckman street are collected and disposed of with the much larger volumes of garbage. This seems to be the most satisfactory means of disposal under the circumstances, but where the wet screenings are dumped in large quantities into an incinerator, as attempted at the Jamaica plant, it has been found to interfere with proper combustion.

At Hyperion, the Los Angeles screenings are buried in the sand but are exposed to a certain extent by the gulls that are attracted to the spot and some more satisfactory method of disposal is being sought. Experiments reported by D. C. Warfel have indicated that by distillation there may be recovered from one ton of screenings 85% moisture, about 800 cubic feet of gas containing 400 B. t. u., 100 pounds of fuel oil, and 150 pounds of fertilizer base containing 1½% nitrogen, 3.2% phosphorous acid and 1% potash, valued at $1.50 per ton of wet screenings. These experiments are to be extended and the foregoing results must be considered provisional.

Long Beach, California, appears to have solved the problem of disposing of its screenings satisfactorily by incinerating them in a home-made furnace with natural gas supplied by the municipality, a plan which under existing conditions is economical and satisfactory and it deserves consideration when cruder methods are unsatisfactory.

SEDIMENTATION TANKS

Sewage should be discharged from sedimentation tanks before it becomes septic; therefore contact with decomposing sludge or a long period of detention in the tank is generally to be avoided. Consequently, the plain sedimentation tank with mechanism for the prompt removal of the sludge has come into favor. At the plants visited, plain sedimentation tanks with hopper bottoms were found in two cases, Imhoff tanks in three, and tanks with mechanical removal of sludge at eight plants for final settling and at two of them for pre-settling as well. Link-Belt, Hardinge and Dorr clarifiers were found at the several plants.

Each of the above type of tank has a field of usefulness; the hopper bottom and the Imhoff tank where their depth is not too costly, the hopper-bottomed and those mechanically cleaned where the sludge can be disposed of while fresh or held to decompose as in digestion tanks. Tanks of the clarifier type appear to be especially adapted to situations where excavation is costly, to final settling in connection with activated sludge or trickling filter plants or where removals of 40 to 50 per cent of the suspended matter is desired within relatively short periods.

The committee describes briefly the advantages of sludge digestion, and the operation of the Antigo and several of the other sludge digestion plants, all of which have been presented at greater length in PUBLIC WORKS during the past few months.

THE ACTIVATED SLUDGE PROCESS

Pre-treatment of sewage to be activated is performed by fine screening at five of the plants visited, including three plants where fertilizer is produced, fine screens generally taking less space and being less costly than sedimentation tanks. Shallow sedimentation tanks affording brief detention, however, may be quite as cheap and also permit removal of grease by skimming.

In the matter of aeration, the "Manchester system" of spiral flow is adopted at five of the plants. Experiments at Pasadena have shown no advantages in spiral flow, probably due to the narrowness of the tank. At Harbor City, perforated pipes were adopted in place of diffuser plates for economical reasons in a temporary plant, but with apparently good results. At Pasadena the Norton plate has replaced the "Filtros" plates used heretofore, being durable and efficient and no more expensive. The experiments in mechanical agitation being conducted at the Des Plaines River works have not been carried far enough to arrive at conclusions. The committee believes it desirable to carry on experiments in the use of mechanical agitation rather than diffusion by compressed air, since a large part of the operating costs of activated sludge plants is due to the power used for aeration and agitation, the efficiency of which is very low. Efforts looking to a more economical use of air seem likely to result eventually in lowering the cost of power, whether by more effective baffling, by decreasing the submergence of the diffusers, or by surface agitation. As surface agitation implies shallow tanks it usually means larger acreage, which tends to increase the construction cost. Also climatic conditions should be considered in the northern United States, where large areas of shallow tanks might present difficulties.

In the plants visited, the amount of air required varied from 0.95 cubic foot per gallon of sewage at Milwaukee to about 4 at Grand Canyon, but was under 2 in all except the Grand Canyon and Houston plants. The excessive use of air at Grand Canyon was explained in the description of that plant in "Public Works" a few months ago.

The committee gives the cost per million gallons

daily capacity of construction of activated sludge plants at the several cities, explaining that locality, size of plant and many other factors tend to complicate comparisons. The cost per m. g. d. varied from a minimum of $22,000 at the south side Houston plant, to a maximum of $485,000 at the Grand Canyon plant, the latter including connection trunk sewer and outfall. The costs of the plants proper seemed to all fall under $100,000. The cost of operation per million gallons, exclusive of fixed charges, varied from $9.73 at Indianapolis to $44.75 at Pasadena, the latter being exclusive of revenue received from fertilizer.

Concerning the action of activated sludge plants, the committee states that a septic sewage is less amenable to flocculation than one that is fresh. In addition to this, it is necessary to intensify flocculation by "conditioning" the sludge—that is, to increase coagulation by means of chemicals. For this purpose, sulphuric acid has been generally used in the past at Milwaukee and sulphate of alumina at Chicago, but more recent experience at both plants points to the use of chlorinated copperas or ferric chloride. The choice depends in part on the cost and in part on the condition of the sludge. At Milwaukee all three of the above conditioning agents are used in turn, depending upon temperature conditions; sulphuric acid in summer and chlorinated coppers in winter. Ferric chloride, tried at the Calumet plant, appears to be more effective in producing high rates of filtration but its cost has generally precluded its regular use. To promote filtration and drying, "Filter Cel," a diatomaceous earth, is used at Pasadena. Its effect is purely physical but it is effective in promoting filtration. For eastern plants, freight charges would preclude its use and a further disadvantage is in the dilution of the fertilizing ingredient of the product, "Milorganite" from Milwaukee containing about 7 units of nitrogen as compared with 5½ units in "Nitroganic" from Pasadena.

In the matter of dewatering, the modern Bescoter-Meer centrifuge was found satisfactory in some respects with activated sludge at Milwaukee but was abandoned on account of the cost and the large amount of fine suspended matter in the effluent that had to be returned for treatment. After experiments with various devices, the Oliver filter has been adopted at Milwaukee, the Calumet plant of Chicago, and at Pasadena; the Berrigan Press at the Des Plaines River Works, Chicago; and at the north side plant at Houston an American continuous vacuum filter is being installed. By these devices the moisture is reduced to a point between 75% and 80%, so that further drying by heat can be economically carried out.

The filter cake is dried in Atlas dryers at Chicago and Milwaukee, and in Ruggles-Coles dryers in Pasadena. At Houston, Buckeye dryers are being installed. The product from the dryer is ground, sifted and sold at Milwaukee at a net price, exclusive of freight, of about $15 per ton ($25 including freight charges); at Chicago, $25 per ton in carload lots; and at Pasadena $32 per ton, f. o. b. cars.

The manufacture of fertilizer from activated sludge requires considerable capital outlay and careful technical skill as well as educational work in building up a market, but the inherent value of the material is such that the revenue from sales under present conditions should about offset the cost of manufacture where transportation facilities are good and the market not too distant.

Chlorination of the effluent is carried on at Lodi, Pomona, Pasadena, and Grand Canyon; in the first three instances to protect irrigated lands from any germs of disease that might survive, and at Grand Canyon for the protection of any who might inadvertently use the effluent for drinking purposes in place of the restricted water supply. The situation in each case is exceptional and the extent of chlorinating an activated sludge effluent from which practically all pathogenic organisms have already been eliminated would not under ordinary conditions be justified.

A Study of Residence Driveways

Standard design to minimize interference with street traffic in entering or leaving driveway

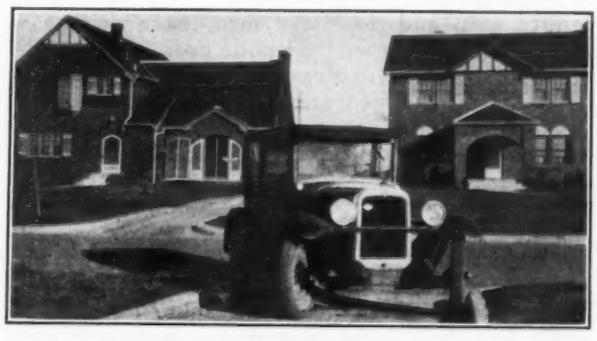
By P. L. Brockway*

The term "residence driveways" is used here to include the opening through the ordinary street curb at the edge of the paved roadway and the paved ramp from the gutter line across the planting strip to the edge of the sidewalk nearest the curb.

It is found that automobile drivers are frequently annoyed and even endangered by an automobile which, when entering a narrow driveway, drifts diagonally to the left side of the street and then turns squarely across it in order to enter the driveway. To avoid the necessity for this dangerous practice, it is obvious that the narrowest pavements should be provided with the widest driveways, but a passing inspection in many cities shows no such relation between the two in actual practice.

With streets 26 feet between curbs in single-family residence districts, if each residence on a 40 or 50-foot frontage is served by a driveway of width adequate to permit an automobile of average length to pass readily from the property to the street without driving to the left of the center, from one-half to two-thirds of the curb line will be occupied by driveway openings, the parking space will be reduced correspondingly and tree lines will be interrupted unduly.

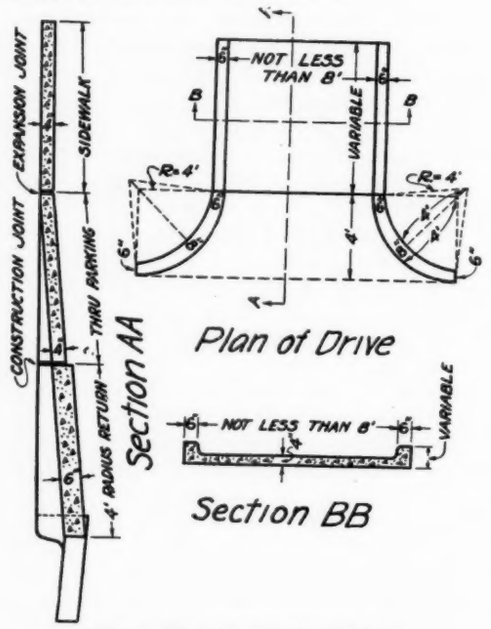
*City Engineer, Wichita, Kans.



POSSIBLE TO TURN INTO STANDARD DRIVEWAY WITH A SHARP ANGLE

The additional cost of the wider driveways could better be used in adding four feet to the roadway. With a 30-foot roadway it is possible with careful driving to operate two lines of moving vehicles with cars parked on each side, and the added two feet on each side of the center of the street makes a very material difference in the width of driveway necessary if cars entering such driveway observe the regulation of never driving to the left of the street center.

For these reasons the engineering department of Wichita, Kansas, adopted 30 feet as the standard width of roadway in all residence streets whenever possible, and designed a standard driveway opening to be used in combination with this standard width. After making numerous driving tests in the field, the driveway plan shown in the accompanying sketch was tentatively adopted. The standard plan gives the clear width of driveway not less than 8 feet, and this is sometimes increased to ten feet in connection with the narrower roadways or where the longest cars are to be used.



DETAIL PLANS OF STANDARD RESIDENCE DRIVE

The photograph shows the angle at which a short car may enter without touching either curb. The car in this particular case approached the drive parallel to the curb, with the nearer wheel four feet from the curb. Cars of average length can, and do, drive into these driveways at a reasonable speed without crossing the center of a 30 foot roadway.

The better appearance of uniform driveway openings and greatly improved driving conditions appealed to property owners and car operators so almost universally that the tentative standard was enforced in the construction of driveways during the following year.

Up to this time the private driveway had been considered the private concern of the individual and not even the type of surfacing back of the curb line had been specified. So much poor work under this free-for-all system developed so many shattered, broken driveways, that specifications of mixture and thickness, with inspection, were enforced in connection with the standard plan.

In some cases houses are so located that the driveways must be placed at the extreme edge of the lot and occasionally the adjoining owner has objected to the breaking out of any of the curb in front of his property for the purpose of rounding the corner to the entrance of his neighbor's drive. One owner brought suit against every one concerned because of this breaking of his curb, but no court decision was reached because the case was settled by agreement between the owners.

Many driveway openings were constructed under public contract in streets which were being paved, and in order to induce owners to complete the pavement across the planting strip they were allowed to pay for it in ten annual installments with the general paving assessment; which plan proved to be quite popular, and very little opposition developed against the added expense for the wider drive.

No ordinance had been adopted requiring owners to adopt the department plan but it was believed that the city had a right to control the design of driveways in public streets in the interest of reducing traffic hazards.

After three year's use, during which the design was sold to property owners only on its merits, the legislative body established it by an ordinance. This ordinance has not been tested in the courts and it does not now appear that it ever will be, although prior to the ordinance one owner had threatened injunction proceedings. It gives the engineering department authority to vary from the standard design where trees will be damaged unnecessarily or other undue hardship might result, which conditions are very rare—probably not more than one in five hundred driveways.

Airport Data From Cities

In the questionnaire sent to city engineers recently, data regarding airports were asked for. Of the 600 cities which had replied when this synopsis was made, 236 reported having airports, either private or municipal. The wording of the question was "Has you city an airport?" From the answers, it appears that a number of cities, believing this related to municipal airports only, answered in the negative, even though it was served by a private field. Also, 32 cities took occasion to state that they contemplated or were about to begin airport construction.

Most of the airports were financed through the Chamber of Commerce (23), bond issues (26), taxes or general funds (32), subscription (18), stock sales (8), or by private sources (53). Other sources included American Legion, donations, Park Board, Board of Trade, civic clubs, Air Derby, county, revenue from auto raffle, community club, loan, and state funds.

The principal types of surface used for the runways included "none" (53), earth or dirt (20) and

grass or sod (30). Other types were oiled macadam, asphalt macadam, oiled, oiled cinders, Bermuda sod, volcanic cinders, oiled sand, and sand-clay, 1 each; oiled gravel, 2; cinders in shell base, oiled, 1; macadam, 3; cinders, 3; gravel, 8 and clay, 2.

Much importance is attached by designers to distance from the city center. Eight cities reported their airports less than 1 mile from the city center; thirty-three were 1 mile; sixty were 2 miles; fifty-four were 3 miles; twenty-four were 4 miles; fourteen, 5 miles; eleven, 6 miles; six, 7 miles; five, 8 miles; one, 9 miles; two, 10 miles and one each, 11 and 12 miles.

Construction Methods and Plant on Mississippi Levee Construction

In a previous article Mr. Slade outlined the history of the development of flood control along the Mississippi, and traced the evolution of construction methods, from the shovel and wheelbarrow days, up to the years just before the 1927 flood. In this article he describes in detail machinery and methods now in use and results obtained.

By Herbert T. Slade*

The rapid developments in levee construction requirements during the past few years have made necessary the use of equipment capable of handling economically large volumes of earth; with old types of machinery, contracts ranging from 60,000 to 100,000 cubic yards were about the maximum that could be handled. At the same time, earth-handling machinery of all kinds have been developed wonderfully since the beginning of the World War, what with the stimulus given to invention by the necessities of the war and the scarcity and high wages of labor since the war; and contractors on levee work naturally have utilized the latest developments in equipment and methods.

TOWER MACHINES

About the time that the World War began, what was known as a tower cableway was being tried out; and after the war, the Government built and operated successfully a number of these machines, using hired labor or force account. These tower machines consisted of one main tower and one tail tower. The former was 80 to 120 feet in height, built up on a base of from 36 to 60 feet, and mounted on trucks which travelled on two double steel-rail tracks built in sections, with a special crane attachment for skidding these sections forward and placing them ahead. The operator's cage was on the main tower about 60 feet above the ground where he could get a good view of the entire pit and cable way. The tower machine was operated by steam, which was furnished by two boilers which were mounted on the main base together with engines and other equipment, all of which helped to serve as a counterweight for the tower.

The cableway consisted of about 1,400 feet of 2-inch wire cable extending from the main tower (which travelled on the inside or land side of the levee toe) back to the tail tower, which was moved forward by cable and drum, cables being attached to tree trunks or dead-men. This tower was moved along just back of the extreme back of the pit line.

The bucket, which was 6 to 10 cubic yards capacity, traveled on the main cable by means of a smaller cable and sheave, and could make an average trip in about two minutes. A steam stump puller was

*First Lieut., Corps of Engineers Res., in charge of Reelfoot Levee District.

SHOWING DRIVEWAYS CUT THROUGH OLD LEVEE, NEAR JUNCTION OF NEW, FOR HAULING DIRT FROM PITS BACK OF OLD LEVEE AND AT THE SAME TIME MAINTAIN THE BEST PROTECTION

This old levee will be removed by big machine in building main levee section. Taken in February, 1929, with 6 inches of snow on the ground.

BUCYRUS, NO. 24, 115 FT. BOOM, ON T. W. CROW CONTRACT
Showing skid and roller method of traveling.

part of the equipment, and in addition to clearing the right of way of stumps it was used in moving the towers forward.

To operate this equipment usually required from 50 to 150 men, including teams, fresnoes, etc., which were used for dressing and finishing levee, cutting the muck ditch, etc. Such a machine would, under normal conditions, place from 80,000 to 150,000 cubic yards per month by working two shifts. The machine complete, ready for operation, cost around $140,000, but would last a long time; making the average cost per cubic yard, taking everything into consideration, from 12 to 18 cents. Some of these outfits are still in operation and with recent improvements are still more efficient.

DRAG LINES COME INTO USE

Three or four years ago the big drag lines began to come into more general use. The Sternberg Dredging Co., William Roth, general field manager, moved onto a contract in the Reelfoot Levee District, three miles west of Hickman, Ky., on October 10, 1925, and completed the contract of 262,000 cubic yards on January 10, 1926, an average of 87,000 cubic yards a month. This was done with a Monighan 110-foot boom, 4-yard bucket, old-style walking device, operated by a 3-cylinder, 180-h.p. Fairbanks-Morse Diesel engine. This levee had a base of about 140 feet, average height 16 feet net with 25% shrinkage, and 40-foot berm. Pits were dug 1 on 1 to a depth of 3 feet, then 1 on 50 back toward the river. In this work, from 20 to 30 per cent of the dirt had to be rehandled. The material was a sandy loam, with no clearing or grubbing except occasionally a blind stump; the weather was good for the first two months, turning to cold, rain and freezing. The contract price was 24 cents a yard.

This dragline was run in two shifts, and the entire force for the two shifts consisted of 3 operators, 3 oilers or engine men, and 6 to 12 laborers; with an average of two teams hauling supplies and dressing the levee.

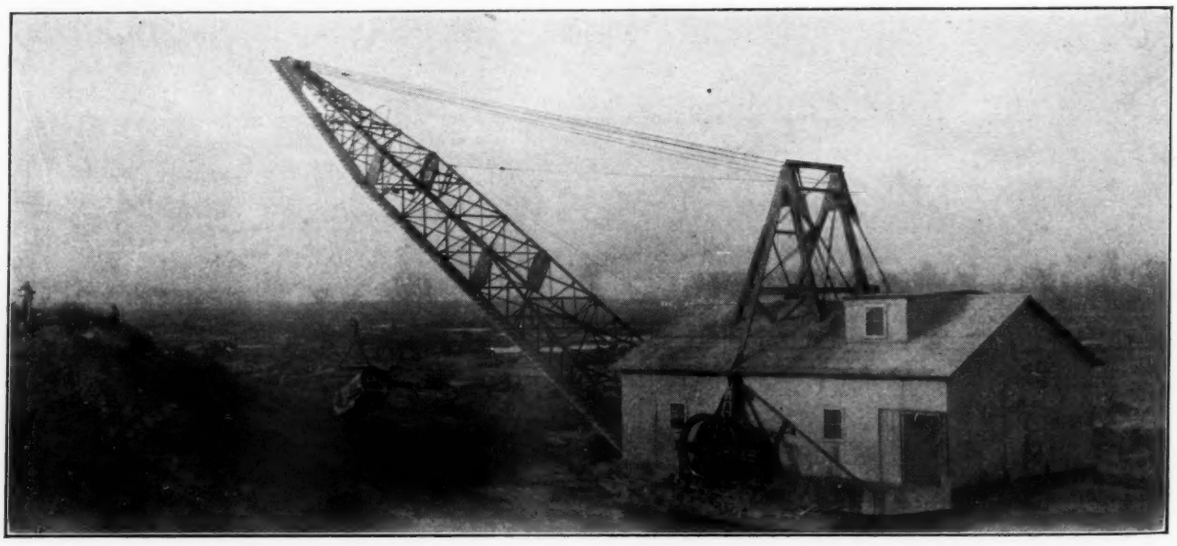
1928 LEVEE CONSTRUCTION IN THE REELFOOT DISTRICT

August, 1928, found the Reelfoot Levee District with 1,400,000 cubic yards of earthwork contracted for completion by December 31, 1928. This meant that an average of 350,000 cubic yards had to be moved per month, with no assurance regarding the weather.

On August 20, C. I. Jones arrived on Contract 5, which is eight miles west of Hickman, Ky. The work on this contract consisted of cutting off the top of the old levee for banquette, and putting on a river side enlargement, the contract calling for 109,000 cubic yards.

The equipment brought on the job consisted of a Monighan drag line with an 80-foot boom and 2½-yard bucket, and a No. 25 Bucyrus steam dragline, skid and roller type, 115-foot boom, 3½-yard bucket; the latter being the equipment of the subcontractor, Douglas, Buchanan and Crow. The Monighan moved ahead along the edge of the borrow pit, digging 50 feet back from the edge, and throwing the material back within reach of the Bucyrus, which moved along the outside levee toe and rehandled it to place.

This contract was completed by November 5, with an average of over 43,000 yards a month, including shutdowns. The weather conditions were good; the material was sandy loam; pits in woods, otherwise good; contract price was 43 cents per yard. The force consisted of 2 to 3 operators for each ma-



MODERN MONIGHAN, 110 FT. BOOM, 4 CU. YD. BUCKET, OWNED BY WM. ROTH, WORKING ON REELFOOT LEVEE DISTRICT

chine, 3 firemen, 8 laborers and 2 teams. This did not include clearing of the borrow pit, which cost $20 per acre.

Another Bucyrus 24, same type as the one mentioned above, was employed on Contract 6a for the purpose of placing the top part of the levee section, the banquette and base of the levee being built with tractors and wagons, with small draglines loading from the back portion of the borrow pit. This topping out required about 1,000 to 1,200 cubic yards per station. The machine traveled along the berm, which is 110 feet wide, and was able to reach about 90 feet of the levee side of the borrow pits, which had been left for this purpose by the tractor and wagon units. On December 31, 1928, this machine had placed 120,000 cubic yards, an average of 60,000 yards per month, including breakdowns and time losses due to bad weather. The material was sandy loam, the weather fair, the pits good.

On December 30, 1928, William Roth moved onto contract two a Monighan 110-foot boom, 4-yard bucket, operated by a 3-cylinder Fairbanks-Morse Diesel engine, with the latest walking device. This work was also partially performed by tractor and wagons, and teams and wagons were used also. There was about 30% rehandle. On February 16, 1929, this machine had placed 116,000 cubic yards, rehandling some twice. There was one breakdown of four days. Double shift was worked about two-thirds of the time. Material was sandy loam, pits were good to fair, no timber and few stumps.

HANDLING WITH WAGONS AND TRACTORS

On Contract No. 2 George Morgan tried, beginning Sept. 25 and ending Dec. 10, a 1¼-yard, 45-foot boom, P & H drag line, loading into three 7-yard Western crawler wagons (another one being held in reserve) pulled by Caterpillar "60" tractors. In dry weather this hauling equipment did well, but was not so satisfactory in mud or bad fill conditions. A shovel also was tried on the P & H, but the conclusions were that the drag line was the best method yet developed for loading wagons. The tractor and trailer equipment is very good during the dry season, especially for hauling in the distant materials

HAULING IN TO NEW LEVEE FROM PITS BETWEEN OLD AND NEW. OLD LEVEE AND CAMP TENTS IN BACKGROUND

LOOKING FROM TOP OF NEW LEVEE TOWARD OLD AT JUNCTION POINT
Bucyrus in foreground; team wagons and small dragline loading units in background

and building the base, but did not prove entirely successful in rain, mud or shaky fills.

There was also a double unit consisting of two Bucyrus Erie "30" drag lines with 1¼-yard buckets, loading five Austin 7-yard crawler wagons, which were pulled by Caterpillar "60" tractors. These units were working under conditions somewhat similar to those given in the cost table included in this article, except that pit conditions were somewhat better and the average haul was about 500 feet. These units, with only five wagons in all, averaged 2,800 cubic yards per day, working double shift, including time lost by rain, or an average of 3,000 yards per day while working. This work consisted of building banquette only, that is, a section about 120 feet across the base, 40-foot crown, average height 12 feet, slopes 3 on 1 front and 4 on 1 rear. This material was excavated far enough back to leave about 2,000 yards per station in front of the pit to be used for building the main levee section. The price on this work was 22 cents per yard.

The base of the main levee section, consisting of about 1,000 yards per station, was then built from the back portion of the remaining pit with two 1¼-yard Northwest draglines used for loading two Streich 12-yard double crawler wagons, one 10-yard Biehl crawler wagon, and two 5-yard Euclid crawlers, all of which were pulled by Caterpillar "60" tractors. The average haul was about 350 feet, and the two draglines, together with the seven wagons and six tractors, averaged about 4,000 yards per day, double shift. The price was 26 cents.

The remaining 90 feet of the pit was handled with a Bucyrus "24" skid and roller, 115-foot boom, 3½-yard bucket, which traveled ahead on the 110-foot berm and finished the section without rehandling, moving 1,000 to 1,200 yards per station. This machine averaged about 2,000 yards per day when working double shift, the price per yard being 26 cents. The average height of the main levee was 20 feet.

A part of this work has been done also by 4-mule dump wagons, some loaded by elevating graders and some by 1¼-yard draglines. At the present time there are eight 1¼-yard draglines and one ¾-yard

LOADING TEAM WAGONS WITH 1¼ YARD "NORTHWEST"

steam shovel loading team wagons. The new Levee Special elevating grader, which is equipped with a gasoline engine for operating the elevator, with automatic belt adjuster, will do the work of two or more of the old type loaders. But it is the general opinion that, except where conditions are favorable for the elevating grader, the drag line is more efficient in loading.

SIZE OF CONTRACT AND WORKING

Levee construction work is usually advertised in the spring. The working season in general extends from June or July until the first of the year. There are exceptions to this; for instance, falls rains interfere at times, while again open winters, which are more frequent, permit certain types of construction throughout the winter.

In the past, contracts ranged from 60,000 to 300,000 yards, but in view of the amount of construction now to be done, and the improved methods available for handling the work, contracts may run from 100,000 to 1,000,000 yards or more in the future.

The new section, which in this district will be approximately 21 feet in height, requires much more dirt, and there are possibilities for the economical employment of much larger machinery in its construction. The crown of the new section will be 10 feet, the riverside slope 3½ to 1; land side slope 6 or 6½ to 1, and base 175 to 225 feet. There will be some variation due to soil characteristics and levee heights.

Heavy equipment is usually moved on the river by steel barge and boat, but good roads are now rapidly being constructed in the delta regions, and railroad service is generally available within a few miles in most places.

Index All Bridges in New Mexico

All highway bridges in New Mexico are to be surveyed, photographed, inspected for condition and given identification numbers by the Bridge Division of the Highway Department.

The results of this work will give a comprehensive, filed report on all bridges of the state, together with their load limits. It is planned to place signs on all the major structures indicating the allowable load and speed limitations.

Northport, N. Y., Sewerage System

A contract was recently awarded for the construction of about four and one-half miles of sewers and a sewage treatment plant for the village of Northport, N. Y. The district served

Cost of Earth Work with Dragline Unit, Nov. 1 to 30, 1928

Average height of levee, 21 ft.; average length of haul, 700 ft.; cubic yards moved, 28,559; total cost, $5,626.57; cost per cubic yard, 19.7 cts.

1928 Nov.	Hrs Wkd	Weather	Pit Cond.	Gasoline Gals	Gasoline Cost	Crude Oil Gals	Crude Oil Cost	Cyl. Oil Gals	Cyl. Oil Cost	Grease Lbs	Grease Cost	Repairs	Labor	Depreciation	Interest	Total for Day
1	0	R	NW	—	—	—	—	—	—	—	—	—	69.33	—	5.78	75.11
2	0	R	"	—	—	—	—	—	—	—	—	—	69.33	—	5.78	75.11
3	12	Cl	B	150	30.00	31	2.48	5	3.00	10	2.50	47.00	84.34	13.27	5.78	188.37
4	24	"	"	300	60.00	62	4.96	10	6.00	20	5.00	—	99.33	26.54	5.78	207.61
5	24	"	"	290	58.00	60	4.80	10	6.00	20	5.00	—	99.33	26.54	5.78	205.45
6	24	"	G	290	58.00	65	5.20	10	6.00	20	5.00	—	99.34	26.54	5.78	205.86
7	24	"	"	285	57.00	63	5.04	10	6.00	20	5.00	—	99.33	26.54	5.78	204.70
8	24	Cly	"	295	59.00	63	5.04	10	6.00	20	5.00	—	99.33	26.54	5.78	206.69
9	24	"	"	295	59.00	64	5.12	10	6.00	20	5.00	—	99.34	26.54	5.78	206.78
10	24	Cl	"	285	57.00	61	4.88	10	6.00	20	5.00	—	99.33	26.54	5.78	204.53
11	24	"	"	290	58.00	64	5.12	10	6.00	20	5.00	—	99.33	26.54	5.78	205.77
12	24	"	"	290	58.00	60	4.80	10	6.00	20	5.00	—	99.34	26.54	5.78	205.47
13	24	"	"	290	58.00	60	4.80	10	6.00	20	5.00	—	99.33	26.54	5.78	205.45
14	24	R	"	290	58.00	62	4.96	10	6.00	20	5.00	—	99.33	26.54	5.78	205.61
15	24	Cly	"	285	57.00	61	4.88	10	6.00	20	5.00	—	99.34	26.54	5.78	204.54
16	24	"	"	295	59.00	63	5.04	10	6.00	20	5.00	—	99.33	26.54	5.78	206.69
17	24	R	"	295	59.00	62	4.96	10	6.00	20	5.00	—	99.33	26.54	5.78	206.61
18	24	"	"	290	58.00	65	5.20	10	6.00	20	5.00	—	99.34	26.54	5.78	205.86
19	12	"	"	145	29.00	32	2.56	5	3.00	10	2.50	61.00	84.33	13.27	5.78	201.45
20	24	Cl	"	285	57.00	64	5.12	10	6.00	20	5.00	—	99.33	26.54	5.78	204.77
21	24	"	"	290	58.00	64	5.12	10	6.00	20	5.00	—	99.34	26.54	5.78	205.78
22	24	"	"	290	58.00	60	4.80	10	6.00	20	5.00	—	99.33	26.54	5.78	205.45
23	24	"	"	290	58.00	62	4.96	10	6.00	20	5.00	—	99.33	26.54	5.78	205.61
24	24	"	"	295	59.00	61	4.88	10	6.00	20	5.00	—	99.34	26.54	5.78	206.54
25	24	Cly	"	285	57.00	60	4.80	10	6.00	20	5.00	—	99.33	26.54	5.78	204.45
26	24	"	"	285	57.00	62	4.96	10	6.00	20	5.00	—	99.33	26.54	5.78	204.62
27	24	R	"	290	58.00	64	5.12	10	6.00	20	5.00	—	99.34	26.54	5.78	205.78
28	24	"	"	290	58.00	63	5.04	10	6.00	20	5.00	—	99.33	26.54	5.78	205.69
29	24	"	B	—	—	—	—	—	—	—	—	—	69.33	—	5.78	75.11
30	24	Cly	"	—	—	—	—	—	—	—	—	—	69.34	—	5.78	75.11
Totals	648			7260	1452.00	1558	124.64	250	150.00	500	125.00	108.00	2830.00	663.54	173.39	5626.57

Equipment Used on This Work

One P & H Dragline, model 700:
- 1¼ yd. dipper, 40 ft. boom
- 4-cylinder Diesel oil burner
- Cost $22,500. Depreciation 20% a year.
- Labor—2 men per shift @ $150 and $140 a month.

Three 10-ton Caterpillar Tractors:
- Cost $4,500 each. Depreciation 25% a year.
- Labor—3 drivers per shift @ $150 a month.

Three Austin-Western Crawler Wagons:
- 7 yds. capacity
- Cost $2,800 each. Depreciation 20% a year
- Labor—3 men per shift @ $3.00 a day.

One 3-up Team to Fresno:
- Labor—2 men @ $3.00 a day.

One Foreman @ $200 a month.

will include the business and main section of the village and will benefit about one-half the population. The sewage treatment plant will consist of an Imhoff tank, sludge bed and chlorination apparatus, plans for which have been approved by the State Department of Health. A permit has been issued allowing the discharge of effluent into Northport Harbor. A bond issue of $100,000 has been approved by the taxpayers of the district.—*N. Y. State "Health News."*

Regulation of River Pollution

Proposal of English sanitarian for a board to control each river and its catchment area, representing all interests concerned

The subject of river pollution was selected by Dr. Edward Ardern, consulting chemist to the Manchester Corporation Rivers Dept., for his presidential address to the Association of Managers of Sewage Disposal Works, of England, at its convention on November 22. In this address he considered first the extent to which pollution of streams should be permitted, and then the means by which regulation of pollution should be effected.

As to the first, he recognized that every stream differed from every other not only in the nature and degree of its pollution, but also in the degree of pollution permissible in consideration of all the affecting conditions. He would set as the minimum requirement for any case a prevention of nuisance and of menace to public health. As had previously been done by a number of federal and state authorities in this country, he divided rivers or sections thereof into three main groups —first, those where contamination must be kept to a minimum, which would include "important fishing rivers and rivers which are or may be used directly or indirectly as a source of water supply"; second, "areas where the amount of permissible pollution will be controlled only to the extent of securing conditions which will not constitute any menace to the public health or detract from amenities of life, including densely populated industrial areas"; and third, "areas which would call for intermediate control, where the self purification effects of the water courses could be utilized in varying degrees but not to such an extent as the biological oxygen demand of the various pollutes is in excess of the recuperative power of the river."

At present the problem is not dealt with in a satisfactory manner because it is "attacked piecemeal by local authorities and manufacturers with little or no attempt at coordination"; different authorities have different views upon the matter and different powers for controlling pollution. At present there are a number of river boards, each having a control over a certain river, or section of a river; but he suggested that each such board should be elected and representative of all the interests concerned—public, industrial, agricultural, fisheries, etc., and be responsible for the state of the river and its tributaries over the entire cachement area of the stream, having executive control over all sources of pollution. The operating expenses of such boards might be levied on the parties concerned directly or indirectly in the use of the river and its tributaries, it being suggested that the basic principle employed in assessing be the extent and degree of pollution by the contributor, and on the other hand the benefit, direct or indirect, derived from the operations of the board. "The first duty of the individual boards would be to survey their area with a view of determining the right policy to adopt in respect of the permissible degree of pollution. The next step would be to coordinate the control of existing treatment plants within their area, and finally to decide what new works would be required to meet the agreed river standard and to carry out such works in due course.

"The maximum permissible pollution coefficient of a river, *i. e.*, the amount of pollution a river may carry without detracting from the amenities or prejudicing the public health, varies, *inter alia,* with the character of its bed and course; *e. g.,* a river, free from obstructions and with a good velocity of flow can absorb successfully a greater degree of pollution than a "silted up" and overgrown sluggish river with a tortuous or winding course. It follows, therefore, that the catchment area boards would have to concern themselves with the physical condition of the main channel in their area and, in a minor degree, of its tributaries, because it may well be that, even from a rivers pollution point of view, it would be found economic to spend considerable sums in improving the bed of the river and in straightening out its course, by reason of the possibility of reaping advantage in a reduction of the first cost and operating charges of treatment plants within the area. In doing so, the additional advantage would accrue of securing improved drainage of the surrounding lands. The work of the Emschergenossenchaft affords many excellent examples of the benefits arising from work of this character; in fact, it is asserted that the cost of reconstruction work on the Emscher and its tributaries has been more than repaid by the value of the reclaimed land, quite apart from manifest improvements in the amenities and great benefit to the public health.

"The advantages of such a scheme as I have outlined may be very briefly summarized as follows:

1. Uniform treatment of the subject throughout the country.
2. Co-ordination of effort in the means adopted in dealing with the pollution of any particular river and its tributaries, with consequent economy in expenditure.
3. The question of centralizing or decentralizing treatment plants in any one area would be decided purely on its merits irrespective of local jealousies.
4. Reconstruction of watercourses in certain areas would not only secure an improvement in the amenities of the district, but might well re-

sult in the recovery of considerable areas of land now more or less derelict.

5. The reproach that is now levelled at certain rivers in this country would be gradually removed at a minimum cost.

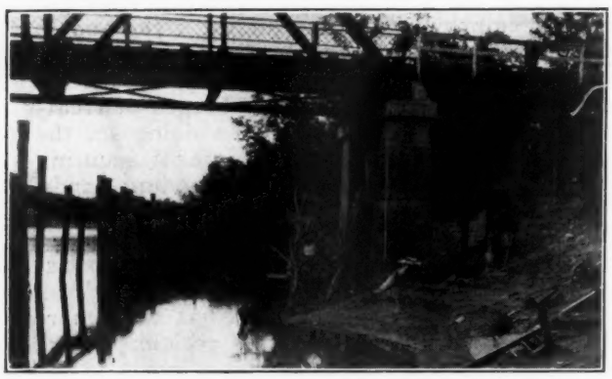
6. The question of pollution by manufacturing trade waste, etc., could be dealt with more satisfactorily and certainly better controlled; *e. g.*, in special cases it might be possible to introduce the American practice of partial treatment as between dry weather and flood conditions, with consequent economic gain without adverse effects so far as the condition of the river is concerned."

Protecting Bridge Pier by Current Retards

By P. K. Schuyler*

The White River bridge at DeValls Bluff, Arkansas, is constructed of the usual type for such locations, consisting of a series of steel spans, the center one of which is of the vertical lift type. All the piers of this bridge are on timber piles. A series of bad floods have occurred in the last few years and there has been a tendency for the channel of the White river to shift to the west bank and undercut the west bank pier. Several years ago some sheet piling was driven around this pier but did not prove adequate because at periods of high water the current cut around behind this piling and eroded a considerable portion of the west bank. An examination of conditions which was made last summer showed a dangerous condition existing at this pier, and also the shifting of the channel away from under the lift span, which might cause the War Department to require the bridge company to move the lift span so as to have it over the channel and this naturally would have entailed a considerable expense.

* Chief Engineer, White River Bridge Corp.



LOOKING DOWN STREAM AFTER A 1928 FLOOD

RETARDS CONSTRUCTED ABOVE PIER

It was determined to undertake the construction of protection work in the form of current retards or wing protection jetties, to be so constructed that they would deflect the current at the point at which it impinged on the west bank and thus would correct the trouble at its source. Permission was obtained from the War Department to construct these retards, this being necessary due to the fact that they were to extend for a short distance out into the channel. The first of these retards was constructed about 450 feet above the bridge and a series of them were built about seventy five feet apart extending to a point below the pier. This work was done by the bridge company's own forces and the total cost of the same was about $3,000. The completed retards are shown in the photograph. A flood which occurred in January proved that the retards were acting in a manner entirely as anticipated and the current was deflected during this period of high water back to its original position under the lift span and no damage or cutting away of the west bank was evident.

Suggestions for City Highway Officials

Contained in address by president of City Officials Division of American Road Builders Association and papers by committee chairmen

Captain H. C. Whitehurst, president of the City Officials Division of the American Road Builders Association, in his annual address at the last meeting of that association, made a number of valuable suggestions for the improving of city highway departments. He called attention to the importance of the subject by stating that, while no accurate figures of total yardage of pavements or improved streets covering all the cities of the United States had ever been compiled, it was "conservatively estimated that the total exceeds 20,000,000,000 square yards. Reports and estimates of new construction undertaken during 1927 indicated a total expenditure of over $4000,000,000 for roadway paving, to which must be added $100,000,000 for maintenance. These figures do not take into account the expenditure for alleys, sidewalks, grading, road replacements, and other municipal highway projects, such as street widening, bridges, and grade crossing elimination projects."

The work of the division had been organized under four heads, those of "organization, administration and finance," "design and construction," "maintenance," and "traffic;" and he divided his remarks in the same manner.

Under the first head, he emphasized the necessity for more complete and reliable cost data. Cost

records, said he, are "vitally essential to the efficient and economical operation of any city street or highway department, no matter how organized or administered. You would be surprised to know that few cities of hundreds we have been in touch with keep any cost records, as we understand the term. Some have records of labor and material, but only a very few can give you accurate cost data of various operations. Without these, how can we compare methods? How can we say we are operating economically, or how can we be assured we are getting the most out of our appropriation? . . . Cost data are essential to the proper and efficient management of a municipal highway department; without it, who can say when pavements and plant replacements are to be made or decide dozens of other questions? . . . Such records would not only guide the engineer in maintenance work, but materially assist the designing and construction engineer in the selection and design of types of pavement."

Under the second heading he emphasized the importance of field control and inspection. "Associations, research bureaus, federal agencies and others have given us data for design and construction based upon scientific research and experiments that guide both the state and municipal engineer on the right path in this field; however, not one has put forward an educational campaign to insure the proper construction." Aside from failures due to mistakes in judgment and subgrade conditions, he believed that 90% of the failures of streets and roads are due to poor inspection and lack of field control, or to improper maintenance. "We carefully investigate the qualifications of applicants for design and field engineering positions, spend thousands of dollars in preparing plans and specifications, much time and thought in testing and selection of materials, and then turn the work in the field for actual construction over to men who oftentimes fail to carry out either the spirit or intention of the work, either through incompetency or neglect."

Of thirteen cities visited by Captain Whitehurst, in eight there were no inspectors on the work, in four of them where inspectors were present they did not have, nor had they seen, the specifications; and in the remaining three, inspectors were present with the specifications but only two had read them. On the other hand, state highway jobs visited by him were all well conducted, with an inspector present and in each case he understood his work. If for political or other reasons it is necessary to employ untrained or unsuitable men in the highway department, they should not be used as inspectors, for this would partially destroy the value of the engineers, and thousands of dollars invested in the construction would be jeopardized. If the city is too small or does not have enough work to maintain a good inspection force, it would be well to obtain inspection service from one of the established inspection bureaus.

In many cases where failures of pavements had been attributed to improper design, insufficient cement, etc., it was really due to lack of proper inspection. Some cities have changed their specifications to increase the amount of cement, thereby adding 20c per square yard to the cost, while an equally good result could have been obtained under the old specifications by increasing the cost of inspection by 1c a square yard.

REPORT OF DESIGN AND CONSTRUCTION COMMITTEE

The chairman of the Design and Construction Committee, George B. Sowers, deputy commissioner of engineering and construction of Cleveland, Ohio, outlined the subject to be covered by this committee. In doing so, he took occasion to enlarge briefly on some of the points which he thought needed attention by the committee. In connection with the matter of subgrades, he said that instead of continuing to build thicker and stronger pavement bases in an effort to carry the increasing traffic loads over more or less unstable subgrades, it is more logical and economical to increase the supporting power of the subgrade. In the clay areas of Cleveland, the supporting power of the subgrade is being economically increased by the use of a four-inch cushion blanket course of granulated slag under the concrete base, with plenty of drains to take the water away from the porous layer. The past year has been the third that the porous sub-base has been used. "It has overcome considerable cracking of the surface and the pavements are carrying the maximum loads without failure."

Referring to compacting of the subgrade, he questions whether rolling with a heavy roller does not over-compact some spots of the subgrade, which will later expand to their natural condition and raise the pavement.

Another point referred to was the cutting up of the subgrade, after it had been prepared for the pavement, by trucks hauling concrete aggregate or mixed concrete. This damage has been overcome in Cleveland by requiring that no trucking be allowed directly upon the subgrade or cushion blanket course; but trucking is permitted only upon a plank roadway or equally effective method for distributing the load.

In speaking of pavement bases, he referred to the advantages of the central mixing plant. He stated that the resulting concrete has a more uniform final strength, and there is also the possibility that the transportation of concrete results in the elimination of air entrained in the concrete, which fact may account for some of the additional strength shown by the ready-mixed concrete. Warming concrete for use in cold weather construction is accomplished more easily with ready-mixed concrete than with concrete mixed on the street. He recommends that the committee should develop specifications permitting and controlling the use of such concrete.

In the matter of curing concrete pavements on city streets, where pounding or covering with earth is not practicable, he referred to the possibility of using sodium silicate, asphalt spray, or calcium chloride, all of which are being tried out.

Of wearing surfaces, one of the most important features is a non-skidding surface. Stone, vertical fibre brick, and some bituminous concretes present excellent non-skid surfaces. A cold-laid asphaltic mixture is being tried in the Cleveland area on hills having as high as 6% grade.

Finishing machines, which have been used so successfully on rural highways, have not been perfected for all classes of street paving, with the result that much of the finishing must be done by hand, with consequent uneveness and over or under-compacting and finishing.

"Street castings, manhole tops, valve boxes and catch-basins are pavement details which require

study and standardization. The improper setting of these castings results in holes and bumps. . . . The breaking of manhole and catch-basin tops is a continual source of damage claims in cities having heavy concentrated loads passing over the streets. Considerable study could well be given to the standardization of street castings, their design and construction."

REPORT ON SUBGRADES AND PAVEMENT BASES

"The possible application of the results furnished by highway research to the design and construction of city pavement" was discussed by C. A. Hogentogler, senior engineer of the U. S. Bureau of Public Roads, chairman of the subcommittee on Subgrades and Pavement Bases. This report covered the subject very comprehensively although necessarily not as completely as would have been possible in a text book, summarizing conclusions from the various test roads, investigations of the Bureau of Public Roads and others, relative to subgrade support, rolling the subgrade, the use of porous base courses and of compacted base courses, concrete bases and the use of reinforcement therein. and the function of wearing courses. The conclusions were summarized by Mr. Hogentogler as follows:

Among the strong indications are:

1. Oiling clay and silt subgrades may greatly reduce the possibility of their working up into flexible base courses constructed subsequently. Meagerness of results furnished by this procedure prevents drawing conclusions. Practice deserves trial.
2. Insulating layers of fine grained granular materials prevents soft clays and silts from working up into interstices of overlying base courses. Substantiated more for materials with binder than for cohesionless materials.
3. Porous base courses serve to reduce extent of detrimental frost heave under rigid pavements. Evidence contradictory.
4. Base courses may reduce the amount of cracking in pavements due to non-uniform support but when offering high frictional resistance to slab sliding may reduce the width but increase the number of cracks due to contraction and shrinkage in the concrete.
5. Drainage is effective for reducing the extent of cracking in rigid pavements and failure in flexible pavements. Evidence contradictory. True or not true depending upon many conditions which remain yet to be identified.
6. Tight mesh reinforcement increases very appreciably the resistance of slabs laid on wet subgrades to initial load cracking. Evidence consistent but too meager to furnish definite conclusions. This if true can be considered as an additional benefit furnished by reinforcement when used for other purposes.

Among the established facts are:

1. Increasing the thickness of concrete pavements increases their resistance against breaking into small pieces due to load.
2. Rich mix concrete furnishes more resistance to load breaking than lean mixed bases. This is especially true on wet subgrades where the lean mix bases are apt to suffer appreciable disintegration.
3. Steel reinforcement is more economical than increased concrete thickness for reducing the number or lengths of cracks due to lack of uniformity or to shrinkage or construction in the concrete.
4. Steel reinforcement furnishes the only means for holding fragments of cracked slabs together thus for reducing the extent of spalling and faulting, in pavements. Thus it serves to prevent progressive breaking down under load.
5. Wearing courses on compacted base courses are essential to prevent disintegration beginning with surface abrasion.
6. Wearing courses serve to protect broken concrete bases from further breakage due to traffic.
7. Unless concrete pavements or bases have adequate resistance against initial load cracking, the full benefits to be furnished by the use of either steel reinforcement or substantial wearing courses cannot be obtained.

Building Safety Into the Highway

Engineering features which affect safety —alignment, grade, curves, crown, width, slipperiness, shoulders, guard fences, culverts, bridge approaches, grade crossings and intersections

A paper with the above title was presented before the 15th Annual Purdue Road School by C. C. Albright, office engineer of the Pennsylvania Department of Highways.

He stated that safety is dependent upon several factors, including the driver, car, speed, weather, and design of the highway. The last, the engineer is largely responsible for. Among the important features of the highway design involved in securing safety are the location of the road, that is, relation of alignment and grade; adequate sight distance; proper superelevation of curves; extra width on sharp curves; minimum crown of road surface; freedom from inequalities and slipperiness; proper construction of shoulders, using stable materials; adequate width of pavement for modern high-speed vehicles; proper marking or defining of traffic lanes; safe guard fences; wide bridges with safe approaches; length of pipe culverts adequate to give full roadway width between headwalls; elimination of railroad grade crossings where practicable; proper warning signs where railroad grade crossings are not removed; elimination of highway grade crossing in exceptional cases; pedestrian subways where practicable; and safe road intersections.

Considering the matter of curves and grades, these should be as light as practicable. From an analysis of 1,277 traffic accidents which occurred in Pennsylvania in 1926, assuming the number of accidents on a straight, comparatively level road to be 100%, there was the same percentage on a straight road with light grades, 105% on light curves, 875% on sharp curves, and 508% on steep grades. Light curves were assumed to be less than 10 degrees and light grades less than 6 per cent. This analysis indicates clearly the extra hazards on sharp curves and steep grades. It is the policy in Pennsylvania, where practicable, to keep the curves no sharper than 5 degrees, 44 minutes, or 1,000 ft. radius, and the grade at a maximum of 6 percent. On some mountain routes, 8 percent grades are used, with lighter grades interposed at intervals of 2,000 feet or less. From traffic studies which the department made, the desirability of breaking maximum grades at intervals with lighter grades in order to enable the driver to retain proper control of the car on descending and to prevent undue slow speed in ascending was clearly demonstrated.

Sharp curves at the bottom of long or heavy grades, or at the end of long tangents, are very undesirable. When topography or excessive cost seems to make such combinations necessary, a special design should be devised to reduce the danger. Mr. Albright cited as an illustration a road where there was a hairpin turn on a very steep grade which had been the scene of many

accidents. When this route was improved in 1926 with a hard-surface pavement, the hairpin turn was expanded to a 25-degree curve, the pavement was widened to 30 feet with a curb on the outside and standard shoulder on the inside, and superelevated one inch per foot of width. As a result of this, no accidents have been reported at this point since construction was completed. Pennsylvania also requires a minimum tangent of 150 feet between curves in opposite directions.

He recommends a minimum sight distance of at least 500 feet between points 5 feet above the road surface on all vertical and horizontal curves.

In Pennsylvania the present policy is to superelevate curves sharper than 2,000 feet radius, 1½ to ¾ of an inch per foot width of pavement. In only exceptional cases is one inch per foot super-elevation used. While theoretical values of greater than one inch may be justified on sharp curves for high speed vehicles, it may cause skidding or slipping of slowly moving cars or trucks when the pavement is coated with sleet or snow.

Because of the danger created by the overhang of vehicles on curves, it is the practice to widen pavements on curves of 600 feet radius or less from 2 to 6 feet.

On hard-surface roads the crown should be very light, 1 inch for surfaces 18 and 20 feet in width is the Pennsylvania standard, while additional widths on the sides are sloped not to exceed ¼-inch per foot.

The pavement surface should be free from humps and hollows, with a tolerance of not more than ¾ inch in the longitudinal distance of ten feet. The pavement should be finished with a belt or wood float, giving a granular surface; while on very steep grades a broomed surface, or hillside brick with the wire-cut surface up, or a special open-surface bituminous pavement, may be used.

Shoulders should be well constructed and maintained level with the edge of the pavement, with a slope away from the pavement not so great as to cause a vehicle to overturn if driven onto it or to prevent the vehicle from returning easily to the pavement. The Pennsylvania standard is a drop of 1½ inch for each foot of width to the ditch line or to the edge of excavation or embankment slope.

Where it is necessary on street grades to carry surface drainage in excavation adjacent to the shoulder for several hundred feet, the policy is to construct a paved shoulder with integral curb on the outside. This eliminates the danger of a soft shoulder and virtually provides an extra lane for travel. The ideal shoulder should be composed of material that will resist normal errosion and will support the wheel loads that may come upon it. Many accidents are caused by wheels sinking into a soft shoulder.

In the matter of pavement width, he recommends 20 feet for main highways and 18 feet on secondary roads where there is very little truck traffic. Pennsylvania has not found three-lane roads to be more dangerous than 4-lane roads, but the danger is decreased by defining lanes by proper marking on the pavement or by longitudinal joints. He recommends that all lanes be separated by longitudinal joints both to prevent longitudinal cracking and to serve as guides to traffic.

Guard fences should be erected wherever a vehicle might overturn down an embankment. Wood guard fences are dangerous and obsolete. The Pennsylvania standard fence has wooden posts placed ten feet apart, which carry two ¾-inch steel cables supported on cast iron brackets, 3 inches from the face of the post. At particularly dangerous points the cable is one inch in diameter.

Pennsylvania bridges are designed for trucks weighing 20 tons. The legal limit is 13 tons and the additional weight is allowed for impact or possible increase of the legal limit in the future. Small bridges for two lanes of traffic are made 24 feet clear width, and on primary routes the minimum width is 30 feet. It is probable these will be increased in connection with the revision of standards in the near future. Where a bridge is near a boro, village, church, etc., a five-foot sidewalk in addition to the width just noted is provided at the expense of the commonwealth.

It is the present policy to extend pipe or other small culverts, where the cost is not greatly increased, to provide 10-foot shoulders for future traffic lanes. Headwalls can be omitted usually on outlet end of pipe by lengthening pipe by one or two joints.

Grade crossing of steam and electric railroads constitute one of the greatest dangers for highway traffic. Any factor that impedes the free movement of a motor car over such crossing creates an additional hazard. It is essential, therefore, that the alignment and grades adjacent to the crossing should be light and free from obstruction. Curves should not exceed 6 degrees and grades should be less than 6%. The crossing proper should be paved or planked smoothly or uniformly for a width preferably several feet wider than the paved highway. In Pennsylvania, the average cost of the separation of grades is perhaps in excess of $60,000, which precludes the possibility of separation of grades in the majority of cases. and efforts must be directed to minimizing the danger of the crossing.

The same is true of elimination of grade crossings of highways themselves. Often the danger at road intersections can be greatly lessened by changing the grade of one or both roads, by relocating the intersection, or by widening or daylighting the intersection. Favorable results have been obtained by widening the intersection and rounding off the corners to better accommodate turning traffic. The curve radius should never be less than the minimum turning radius of large passenger cars or trucks. In Pennsylvania there is a special law relative to "authorizing the purchasing or condemnation of unobstructed view at intersections of highways, railways, railroads, and at curves," by which it is possible to eliminate existing obstructions to sight and prevent the erection of any new obstruction.

Oil Roads in New Mexico

Modification of California formula for surface-mix method to meet New Mexico conditions. Some methods and appliances used

In the study and development of oil roads using 60% to 70% asphalt oil mixed with gravel under the specification of the surface-mixed method, it has been learned that the same general principles govern these mixes as control asphaltic pavement. The Division of Highways, California Department of Public Works, and U. S. Department of Agriculture have published an empirical formula, based on the mechanical analysis of the aggregate to be oiled, for computing the amount of oil required to properly bind the particles of sand and gravel in the road. This formula is $P = .015A + .03B + .17C$; in which P is the percent by weight of oil required, A is the percent of metal retained on the 10-mesh sieve, B is the percent of metal passing the 10-mesh sieve and retained on the 200-mesh, and C is the percent of material passing the 200-mesh.

According to H. W. Rice, in an article in the New Mexico Highway Journal, it has been found necessary to modify this formula for New Mexico conditions, increasing the calculated amount of the oil by 20 or 30 percent, the amount depending on the climatic conditions and the nature of the material to be oiled.

A stain test has been developed for determining the proper proportion of oil to use with a given grade of gravel. In making this test, an estimated percent of oil is mixed with the material to be treated (or a sample may be taken from material which has already been processed on the road), and this material is passed through the 10-mesh sieve, separating out all the fine material. A pound of this material passing this sieve is then heated by placing it in a can partially submerged in boiling water for one hour, and is then poured upon a white paper, levelled off and covered by another sheet of white paper, and on top of this is placed a two-inch wooden block. A two-pound weight is allowed to fall freely on this block from a height of one foot, five times. The papers are then removed and the resulting stains on the paper give the indication desired. By comparing the stains thus obtained with stains made from mixtures which have proven satisfactory, the desirability of the mixture can be ascertained.

Mechanical Sieve Shaker.—In applying the formula, it is necessary to screen the material, and the amount passing the 200-mesh screen is seen to be especially important. A sieve shaker is not ordinarily available in the field, and shaking a set of sieves by hand is laborious work and is not often done with sufficient thoroughness. Mr. Rice describes a contrivance, which he assembled in the field from odds and ends which were available, to serve as a mechanical sieve shaker. The power was furnished by a Ford commercial roadster. Three slats were assembled to form a cradle one foot wide and spanning the body of the Ford truck, the ends of the cradle being fastened to the tops of the sides of the truck. A tin pan having an 8-inch bottom was nailed on top of this cradle at the center and in this were nested a set of 8-inch laboratory sieves, which were held in place by a leather strap fastened to the cradle and passed over the top of the sieves. A stick was fastened on top of the cradle with one end just to the right and in front of the can while the other end extended over the side of the truck a foot or so, the cradle being so located that the stick was directly over the hub of the rear wheel. The outer end of the stick was attached by a piece of wire to a pin attached to a plate fastened under the axle nut in such a way that the pin travelled in a circle of 1½ inch radius when the wheel revolved. To give a decided jolt to the sieve at each stroke, a board was tacked to the back side of the cradle so that it struck the floor of the car on the down stroke; and to make this action more positive, a coil spring was wired to the cradle under the pan and fastened to the floor of the car so as to give the desired tension. The rear wheels were then jacked up, and by setting the speed of the motor at the correct point, the apparatus gave the sieve a more efficient shaking than would be possible by hand.

Spreading Gravel.—The quality of the pavement depends upon the correct proportioning of the oil relative to the grading of the metal; and theoretically, as the grading varies, the amount of oil distributed per square yard should vary also; and the amount of oil should vary with the thickness of the metal also. The oil distributors now in use are not capable of varying their output with sufficient accuracy to compensate for variations in the amount of material on the road or in its grading, and the oiling work is therefore laid off in runs, and the amount to be distributed uniformly on any run is calculated for the average thickness and grading of metal in that particular run. It is therefore desirable to maintain the grading of the metal as uniform as possible throughout any given run. It has been found difficult to obtain either uniform grading or uniform thickness of spreading and this problem is one which calls for future study and development.

Road Test in the East Indies

Most road tests in this country are made with the purpose of deciding upon the relative durability of different paving materials or methods. A test is being conducted in the Netherland East Indies with a view of determining the basis on which taxation of motor and other vehicles should be levied, by determining the relative amount of wear by each of several classes of vehicles. The test is being made on a track consisting of two parallel straight stretches each 135 feet long, connected at the ends by two curved sections of 50 feet radius, making an oval track. The entire track is divided into four sections, each containing half of one straight stretch and half of an adjoining curve. One of these is paved with a surface using asphalt furnished by the Standard Oil Co. of New York, another with asphalt furnished by the Standard Oil Co. of California, a third by asphalt furnished by a Dutch company, and the fourth is laid with waterbound macadam.

Each test vehicle is carried on three wheels, the front one connected to a guide rail laid around the

track for guiding the vehicles, while the two rear wheels are those which produce the wear. There is a mechanism in the vehicle which causes the rear wheels to gradually move across the track to prevent their travelling in a rut. Motive power is obtained from an overhead trolley. One of the vehicles is intended to simulate a horse-drawn cart, and in this the tractive effort is exerted on the front wheel; while the other simulates a truck and the traction is exerted through the rear wheels, one of which carries a pneumatic tire and the other a solid tire.

It is expected by these tests to be able to determine the relative amount of wear on pavements of these classes by horse-drawn carts and by trucks with either pneumatic or hard tires, the former travelling at a rate of 3½ miles an hour and the latter at about 15 miles an hour.

Maintaining Dirt Streets

In a paper before the League of Kansas Municipalities, W. E. Baldry, city engineer of Topeka, stated that in all of the cities of that state there were some earth streets to maintain and that many of them formerly used cinders for that purpose and were feeling the loss of the supply, which is being cut off by the general use of oil and gas in power plants and homes. "In the past, probably more earth streets were carried through the muddy season on cinders than any other one thing."

Of late years considerable sand has been used in earth road building, which has caused the development of numerous pit gravel beds and river sand plants. "A proper amount of sand applied to earth streets when they are soft will be worked into the earth with good results, and better if the material has an element of clay in it. The application of sand to dry streets is now attempted, and while this gives at times a dangerous roadbed for automobile traffic, it does keep the dust down and is in place ready to be driven home when rains come to soften the bearing soil under it.

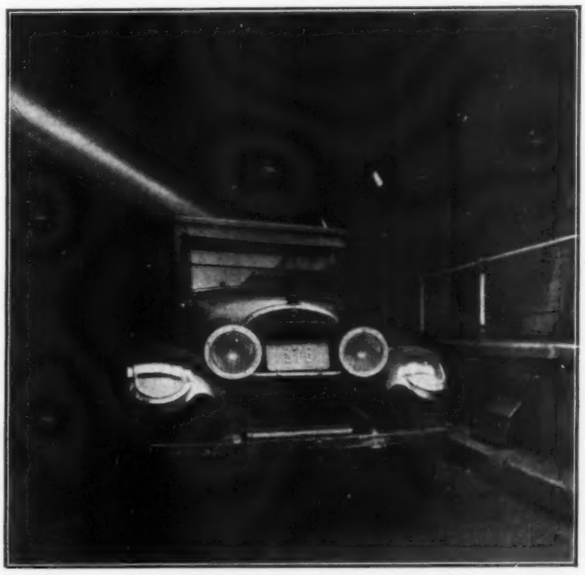
"Many of our cities, both small and large, have some source of sand or gravel within a reasonable haul which could be applied to the streets and place them in a condition for all-year travel at little expense to our citizens. Much material of suitable quality for this service, but wholly unfit for construction of the higher types of roads and streets, is available and the use of it will afford labor something to do through the dull season in the construction and farming industries. I would recommend the hauling of this material by trucks on a yard-mile basis. Such work reasonably well done will offset the necessity for paving of secondary streets in many instances." While paving all the streets of a city to permit the use of automobiles the year round would involve an expense which most of the taxpayers would not care to meet, the use of gravel and sand will afford a fairly satisfactory substitute in many cases.

For maintaining earth streets, Mr. Baldry believes that the best tool in the market today is the motor-driven one-man type of grading machine. Where horses or motor are ahead of the grader, the grader man cannot see ahead of his machine to operate the blade properly, but with the type of motor grader now offered, the blade is ahead of the power, and the operator can see the needs of the road ahead of it. Also, these machines are built for speed and can quickly shape up a sand-improved earth street, replace gravel in its proper position, open ditches, and, when scarifiers are applied, handle ordinary stone-improved roads. Tractors should be used for heavier grading operations, but for quick and regular maintenance use, the motor-driven one-man grader is recommended.

Traffic Counted Electrically

An apparatus for counting traffic automatically by means of electricity has been located at the New York exit end of the New York-New Jersey traffic tunnel, the Holland tunnel. This is an experimental unit, but if the expected results are obtained it is probable that a complete system for electrically counting the traffic in the tunnel will be established in both tubes. The apparatus, of General Electric make, consists of a small floodlight mounted in an inclined position upon the overhead iron work of the tunnel, its slender beam of light falling upon a little circular window in a box placed beneath the sidewalk at the opposite side of the roadway. The box contains a photo-electric tube, an amplifying tube, and an electrical relay. Every time a vehicle passes the spot, the beam of light falling upon the photo-electric tube through the little window is interrupted, so affecting the photo-electric tube that a slight electrical impulse is created. This is amplified by the vacuum tube and fed to the relay. The latter energizes a transmission circuit, the other end of which is in the administration building. There a registering dial is actuated by the electric current so that it turns, registering one more figure, in response to each impulse from the relay.

The engineers have it in mind to divide each



AUTOMOBILE PREVENTING LIGHT BEAM (AT LEFT) FROM REACHING PHOTOELECTRIC TUBE (AT RIGHT)

Light beam has been retouched in photograph to give it prominence

tube into sections and place one of these units at the beginning of each section and one at each end of each tube. The count would be registered upon an indicator board or a succession of dials in either one or both of the administration buildings. By watching the dials one could tell instantly the exact volume of traffic passing through each tube every moment. A sudden large increase in the number of vehicles in one section and a corresponding slight increase in the number in the section ahead would indicate congestion from some cause, perhaps an accident. The trouble point could be more quickly located and the ventilation for that area more quickly regulated than by any existing method. Also this system would indicate the total number of vehicles in either tube in the event of a tie-up, so that the ventilation could be regulated exactly as needed.

Applying Asphalt Joint Filler with a Pressure Distributor*

By H. C. McClure†

A brick pavement was recently completed in Flint, which it is believed, will be of some interest to engineers. The project, known as the North Saginaw Street job, called for a pavement 74-feet wide between curbs, being paved with an entire new brick surface for a portion of the distance, and with new 27-foot strips outside of the street railway track space, for the balance. In all, it totaled around 660,000 yards. The specifications called for an asphalt joint filler to comply with State Highway specifications for this product.

Because of the location of this job, it was deemed advisable to eliminate as much interference on the street as possible, and to reduce complaints and nuisances on the street. The item which was thought likely to cause the greatest objection, was that of heating the filler in small street kettles. The suggestion was made to the contractor that, instead of getting filler in drums and using small street kettles and hand pouring methods as usually employed, he secure his asphalt in insulated tank cars; ship the same directly to the Engineering Department siding where plant steam would be available, and then use a distributor truck for applying this filler. This suggestion was adopted and it resulted in more than the expected degree of success.

The asphalt reached the plant siding at a temperature of 175 degrees F. or above, and required only about four hours of plant steaming to make pumping into the distributor possible. The distributor carried a jacketed pump, operated from a power take-off, which not only fills the tank but circulates or discharges the asphalt, as well, by means of a 3-way valve control. The distributor also carried an air compressor, a portable coal oil torch flame, and two coal oil oil-burner nozzles for heating the asphalt when in transit to the street, or maintaining the asphalt at any desirable temperature. An ordinary fan shapped nozzle was used for applying the asphalt directly to the street, the 3-way valve being opened just a sufficient amount to give the desired quantity for the work at hand. Three men on the squeegees were all that were required for the street end of the work, the nozzle man and truck driver being furnished with the distributor outfit. When the brick surface was laid far enough in advance, it was possible to easily pour three full tanks (700 gallons each) in a single day, and cover in excess of 2,000 square yards of surface. This pouring operation was so fast that the outfit was unable to operate for continued runs of full days, but was required to cut down to two tanks per day quite frequently.

Aside from the advantages to the workmen and to the residents, we believe that the advantage to the job was without question a decided one. The material was maintained within a temperature range of less than 25 degrees, regardless of outside temperature and regardless of the amount of material in the tank, and it was absolutely uniform in every physical characteristic. By applying directly at the desired point, and following immediately with the squeegees, an excessive amount was not left on top of the brick surface, yet all joints were completely filled.

During the progress of the job, sudden summer showers occurred, yet these caused no inconvenience whatever because the pouring operation could be stopped instantly; and on occasions when the rain continued, the distributor was merely drawn back to the yard and the remaining portion in the tank pumped back into the tank car. With this extreme flexibility of operation ,the pouring operation could be continued at various points along the job, with only a few seconds lost time in moving the truck ahead; and a half hour's pouring in one portion of the work required no special set-up and could just as easily be taken care of as a full day's pouring at another section of the job.

In our opinion, the work as we had it outlined at the start, proved to be unusually successful, from the contractor's, city's and residents' viewpoint. There was no more expense in taking care of the work, and the absolute uniformity, flexibility and dependability of this portion of the job recommends itself, we believe, very favorably for work of this character.

*From "Dependable Highways."
†City engineer, Flint, Mich.

Snow Removal on Washington State Highways

The Cascades Mountains divide the state of Washington into two sections with entirely different climates so far as snow is concerned. On the west side the slope is very abrupt to the sea, and most of the land is practically at sea level with very moderate climate during the winter months and little snow. On the east side of the mountains the slope is more gradual, the altitude higher and the climate more severe. Even here, however, drifting snow is the chief cause of trouble. The heaviest snow falls and heaviest drifts are encountered in the mountain passes of the Cascades. The State Highway Department has not attempted to keep these passes open to traffic during the winter, but most of the traffic is routed to the south over the Columbia river highway in winter, and the mountain passes are opened up early in the spring. Aside from these mountain passes, the highways are kept open at all times.

Concerning equipment, the state highway engineer in his annual report says: "From the maintenance records, the best results on snow removal are obtained as follows: 1—Trucks equipped with blade plows for snow up to 24 inches in depth; 2—with V plows mounted on trucks for snow up to 30 inches in depth; 3—after the snow has become too deep to be handled by the above methods, the rotary plow is the most economical. One disadvantage of using the heavy V-type plow is the tendency of the snow to pile up on either side, obstructing the ditches, causing a soft subgrade and the cutting out of the shoulders during the spring thaw. Generally the snow is removed to a width of from 18 to 20 feet, although in snow over 6 feet deep it is cleared to approximately 12 feet.

"During the winter 1927-28 approximately 2,290 miles of highways were kept clear of snow at a cost of approximately $53,000. The equipment used consisted of 171 trucks, 69 truck displacement plows, 6 tractor displacement plows, 4 rotary plows, 17 tractors, 3 tractor rotary plows, and 27 graders. The department has constructed approximately 2½ miles of snow fence."

Highway Officials' Responsibility for Accidents*

Manner in which different highway features may be sole or contributing causes of accidents

What good are highway accident reports if they do not help reduce the number of accidents? For a number of years accident statistics have been collected by various organizations and made available to highway officials and those interested in public welfare. Yet the accident toll is increased and our highways are apparently becoming less safe each year.

In 1925 there were reported 24,300 fatalities from accidents on our public streets and highways. In 1926 these had grown to 25,100 and in 1927 to 26,800.† In the face of the machinery which has been set up for collecting, analyzing and reporting facts regarding highway accidents, and of the high engineering skill which has been developed in highway design and construction, the increase in accidents indicated by these figures is astounding. Our roads are admittedly better built today than they were in former years; our automobiles are the last word in operating efficiency and safety; yet our highways are more dangerous than ever! The answer clearly is that our roads may be relatively safer than they were, but they are not safe enough.

As matters now stand there is no hope of improvement to come from our accident reports and as far as any effect they have on decreasing accidents is concerned the effort involved in collecting them is sheer waste. They serve only to befuddle the issue. They certainly record when, where and how the accident occurred, the type, size and make of vehicle involved, and the driver's name, age, residence and condition. But not a word, not a clew, as to how that kind of accident in that locality might be prevented from occurring again.

The trouble is that accident reports almost invariably assume that in any accident the operator of the vehicle is solely to blame. Perhaps this is because such an assumption, though often at variance with the facts, usually has a measure of popular support. But wouldn't it be better in the interest of public welfare to take an impartial view of the matter and to assume that the road on which the accident occurred may, in its design or construction, be partly if not wholly to blame? Certainly the situation is serious enough so that a courageous acknowledgment of responsibility would be as welcome as unexpected help to a ship in distress.

As an illustration of the erroneous popular viewpoint with respect to accidents, take the matter of speed. When two vehicles traveling at high speed collide, the speed is given as the cause of the accident, which is not true. Speed alone is never a cause of an accident. It does contribute to the damage resulting from the accident, but the accident is always caused by some other fact. For example, when a fast train goes through a derail and is wrecked, the wreck is caused by the derail and not the speed, though the amount of the resulting damage may depend on the speed. Similarly on highways: the accident of two rapidly moving motor cars colliding may be due to any one of several causes traceable directly to the design of the road, such as insufficient width, slippery surface, or obstructed vision.

For any accident the road may be, and often is, directly to blame. The road is always there, always a witness, and as such should be called on the witness stand to give an account of itself. If the road could speak it might point to some neglected detail which started the train of events leading to the accident.

Supposing two vehicles, A and B, collided head-on on a busy highway at night. At first glance the road offers no explanation. It may be straight, level, and wide enough for two to pass comfortably. But how about the center stripe? If the stripe is lacking or indistinct, the road official is partly responsible for the accident, regardless of the location, ages, behavior and other facts about the drivers, and regardless of everything else that may be reported.

Or, there may have been at intervals a culvert headwall looming up in the darkness dangerously close to the pavement edge. The driver of vehicle A may unwittingly have hugged the center of the road to avoid brushing too close to these headwalls, and in so doing hit oncoming vehicle B; in that case the culverts, though none be in the immediate vicinity, are still in a large measure to blame. Another vehicle might hit a headwall head-on; in that case the blame unquestionably would be shared by the road and its builder.

*From "The Highway Magazine," organ of the Armco Culvert Mfrs. Ass'n.
†Official estimate of American Road Builders Association.

Sole or Contributing Cause of the Accident

Accident Reported	No warning sign	No center stripe	Obstructed vision	Slippery pavement	Rough pavement	No shoulder or passing space	No sidewalks	Road too narrow	Unprotected side ditch	No minimum traffic regulations	No highway guard	Culvert too short	Insufficient drainage
Pedestrian run down by motor vehicle			xN	x		x	x	x					
Motor vehicle vs. R. R. train													
A. Train hit car	x		xDN		x								
B. Car hit side of train	x		xDN	x									x
Motor vehicle vs. fixed object													
A. On road	x			x		x							x
B. On shoulders	x					x		x		x		x	
Motor vehicle vs. motor vehicle													
Head-on collision													
A. One car parked				x		x							x
B. Both cars moving			xN	x	x	x		x		x		x	x
Read-end collison													
A. One car parked			xN	x		x		x					x
B. Both cars moving			xN		x	x		x		x			
Side-swiping													
A. One car parked		x	xN	x		x		x					x
B. Both cars moving		x			x	x		x				x	
Broadside collision													
A. At intersection	x		xDN	x									x
B. Open road				x									x
Motor vehicle alone													
A. Overturning	x			x	x								x
B. In ditch	x			x	x	x			x		x	x	x

N—Night. D—Day.

No, the road cannot escape its share of responsibility, nor would it shirk it if it had an opportunity to tell what it knows. In the table given, the road has been given this opportunity, and for each common variety of accident has placed an x under every common defect which may have been the sole or a contributing cause. It is hoped that herein lies a clew as to the most effective way to reduce our rapidly increasing accidents.

Some Concrete Paving Details

In a paper entitled "The Manufacture of Concrete for Pavements," read before the Illinois Society of Engineers, Lee S. Trainor, district manager for McEverlast, Inc., of Los Angeles, reviewed a number of the latest developments in the manufacture of concrete pavements. Referring to high early strength concrete, he stated that this might be obtained by using standard portland cement in a richer mixture with a longer mixing time and less mixing water; or in some cases, by the addition of an accelerator, such as calcium chloride or calcium oxychloride.

In Duluth, high early strength concrete for a business street was secured with a proportion of 1:1½:2¾, a 1½ minute mixing time and reduction of the slump from the usual 2" to 1½". Only 0.43 more sacks of cement per square yard was required than for the usual 1:2:3 concrete. The average strength in four days was 2,136 lbs. per sq. in., five days, 2,434, and at six days 2,948. The street was opened to traffic when the concrete had developed a strength of 2,000 pounds.

In Waukegan, intersections were opened in three days by using a mix changed from the ordinary 1:2:3½ proportions by adding two sacks of cement to the regular five-sack batch, making the proportions 1:1.43:2.5. Only five gallons of water was used per sack of cement, and the concrete was mixed two full minutes. The cylinder strength at the end of three days was 3,090 lbs., at four days 3,470, at seven days 4,000 lbs., and at twenty-eight days 5,214 lbs.

MEASURING MATERIALS

Fifteen states now either require or permit that concrete aggregates be measured by weight rather than volume; and the U. S. Bureau of Public Roads prefers weight measurement on federal aid construction.

There are two types of scales for batching plants —the old platform scale, with its graduated arm and sliding weight, and the dial scale. With the latter the scaleman can watch the pointer as the hopper fills and cut off the flow at exactly the right weight, while with the former scale there is no way of telling when the correct weight is nearly obtained, so a lesser weight is first set on the sliding arm, until the scale beam rises, when the flow of material is cut off, the exact weight is set, and a little more material is added slowly, until the scale beam just floats. A set-back of about 80 pounds is common. While this operation sounds complicated it can be accomplished in the time usually taken to measure a batch by volume.

Recent scales have a combination of the lever scale with a dial measuring the last hundred pounds or so of material, or a pointer which tells the scaleman when the right weight is almost reached.

Most important of all, in the list of better measuring devices, is the improved measurement of water. The great range of pressures in water supply lines, the three-way valve, the tilt of mixers on grades, and the necessity for rapid discharge into the mixer drum, have been a combination which the designer of mixers has found it hard to beat. But engineers have been insisting so strenuously upon the more accurate measurement of water that at last there have been developed several tanks which eliminate most of the old faults.

CURING

Prompt and proper curing, which promotes complete hydration of the cement in the concrete, exerts a profound influence on its life and durability. Curing has, until recently, consisted in supplying moisture to the exposed surface of the concrete by ponding, or covering it with moist earth or straw, or continuous sprinkling. In city work any of these is objectionable; and shortage of water in rural work may cause the curing to be slighted.

Recently there has been offered, as a substitute

for these methods, the spraying onto the freshly laid concrete of a specially processed asphaltic compound employing highly volatile solvents, which forms an impervious coating and prevents evaporation of water from the concrete. Concrete so cured, as compared with that cured by the standard methods, apparently has the same strength under transverse, compression or abrasion tests; and even greater strength where climatic conditions favor rapid evaporation.

Recent Practice on Eastern Highways

Abstracts of papers read before the convention of the Highway Officials of the North Atlantic States, additional to those published last month

RECONDITIONING CONCRETE ROADS

This subject was discussed by Alexander W. Muir, superintendent of maintenance, New Jersey State Highway Department. He discussed it under the four general headings of Patching, Surface Treatment, Thin Bituminous Resurfacing, and Resurfacing with Standard Type Bituminous Pavements.

Patching may be necessary because of openings made in the concrete; failure of part of a slab or of the surface alone. Unless further bituminous material is to be used, the use of bituminous patching is, for the most part, justified only as a temporary expedient; as for instance, during the winter when it is almost impossible to do concrete work satisfactorily.

For patching, crushed stone is probably the most satisfactory mineral aggregate, but where only thin patches are to be made, a sand mixture will give satisfactory results. The larger and deeper the patch, the larger may be the coarse aggregate used. The surface should always be given a fine aggregate seal coat, but this should be only sufficiently thick to protect the surface, give a neat appearance and a smooth riding surface.

Perhaps the most commonly used method is cold patching, for which some prefer a cut-back asphalt, some a cut-back tar, and others an asphalt emulsion. The emulsion cannot be used in freezing weather, but at other times will generally be found more satisfactory, due to the fact that there is less likelihood of producing an unstable patch, and that the material requires no curing period after preparation before it is used. Cut-back tar or asphalt should always be cured for at least 24 hours before use, to permit the escape of the volatile solvents, for otherwise a soft and unstable patch is almost sure to ensue, especially where the depth of patch is considerable.

In hot patching the bitumen may be mixed with a mineral aggregate and then placed, or it may be applied by the penetration method to aggregate previously placed. By mixing it before placing it, it is possible to measure both the bitumen and the mineral aggregate with fair accuracy and secure definite and satisfactory proportioning.

Another method is the use of natural rock asphalt or of Amiesite. The former is particularly suitable for maknig thin surface patches, is easily stored, shows very little deterioration while in storage and is easily handled. Amiesite stores well for a little period and gives excellent results when properly handled.

The use of hot bituminous mixture is practicable in general only in the vicinity of permanent or semi-permanent asphalt plants; but where any considerable area is patched, it is probable that a more permanent and satisfactory surface will be obtained with hot mixtures.

In surface treatment, areas badly disintegrated should be removed and patched, generally with a bituminous mixture, sufficiently in advance of the application of the surface treatment to permit the patches to become thoroughly consolidated and cured. One of the various grades of tar is more likely to prove satisfactory than asphalt for this work. Some use a cold tar of a grade similar to Tarvia B; others use first a tar considerably lighter than Tarvia B as a priming coat, followed with a considerably heavier grade of tar; but probably the use of Tarvia A in a single treatment is preferable.

The author does not advocate the use of sand for covering the tar, as it tends to form a soft, unstable mat. Considerable quantities of slag chips have been used with marked success. Fine gravel has been used but is not advocated by the writer of this paper. Fine stone chips, especially those of trap rock, give an excellent wearing surface, and pulverize very little under the roller.

Patching work should be followed up at considerable intervals with additional treatments to preserve the life of the bitumen; but these should not be frequent enough to permit the building up of a soft, unstable mat.

Discussing bituminous resurfacing, the author says that where the resurfacing is of sufficient depth only to provide a protective coating, he believes the pavement should still be considered a concrete one, but where it approaches the depth if a standard bituminous pavement, the concrete pavement becomes only a base.

For light resurfacing, natural rock asphalt, where available, seems to be highly suitable, giving satisfactory results when used in thicknesses very materially less than the average thickness of a bituminous surface. A thickness should be used not less than approximately one-inch when compacted. Care should be exercised to see that the material delivered is uniform in quality.

Considerable work has been done in Connecticut with fine Amiesite and fine hot-mix bituminous concrete. The maximum size of aggregate in such mixtures should not exceed one half the depth of the surface applied. In surfacing in New Jersey, one-half inch thick appeared to be excellent at first, but disintegrated in about three years and was replaced with a thicker surfacing. Asphalt blocks only 1¼" thick have been used with success in some instances.

It would appear from the above that the use of a surface sufficiently thin to be considered as merely a protective coat is not economically sound, and where bituminous resurfacing is done, it should be approximately as thick as a standard bituminous pavement.

In resurfacing with standard type bituminous pavement, the concrete pavement should first be gone over and all broken-up areas removed and replaced with concrete; the use of black base is not recommended under such conditions because it gives a non-uniform support to the pavement. The author does not consider the smooth surface of a concrete pavement as being objectionable when used as a base, as he believes that pushing and rolling of the asphalt surface are more functions of the bituminous mix than of the nature of the base. "Where a concrete pavement can be placed in satisfactory condition to serve as a base, the experience of many authorities indicates that its resurfacing with a bituminous pavement is economically sound and will furnish a pavement which will give eminently satisfactory service over a considerable term of years."

SEALING OF CRACKS AND SURFACE DEFECTS IN CONCRETE PAVEMENATS.

In a paper by this title, Harry C. Carsten, supervisor of repairs, State Highway Department of Connecticut, said that crack fillers of materials other than bitumen had in general proved unsatisfactory. If expansion joints or cracks are entirely filled with filler material during the early spring or late fall, expansion of the concrete by heat in the summer will force out the bitumen on to the surface, where it will be spread by traffic, causing an unsightly and undesirable condition.

Connecticut is using a special commercial asphalt crack filler for sealing expansion joints and large cracks, and a cut-back asphalt for sealing small cracks; the latter readily enters the small cracks and, being volatile, allows the asphalt to return to its previous density. As the two materials are so different and differently applied, it has been found more efficient to seal joints and large cracks at one time, and the small cracks at another time and with different equipment.

For pouring the concrete, a special pot is used by the department having the shape of a cornucopia with a ball valve at the bottom, operated by the hand which holds the pot. The opening of the pot is kept easily over the joint or crack to be filled and the valve closes rapidly when the end of the crack is reached, preventing drip.

One half of the roadway is treated at a time, leaving the other half free for traffic, and the equipment is kept between the men and passing vehicles, thus protecting the men.

In sealing either joints or cracks, all loose concrete, dirt and dust should be removed; also all moisture, as otherwise the bitumen will not adhere to the sides of the concrete. A very effective way to clean the joints and cracks is with compressed air, using a small nozzle or air jet on the end of the hose; which also aids in evaporating the moisture. A portable heating kettle is used, and for large expansion joints and large cracks the temperature is raised to approximately 250°. The asphalt is filled to within ¼ inch of the surface, and before it has cooled, dry grits up to ¼ inch size are applied by containers similar to the asphalt pouring pot. The grits should never exceed in size approximately one-half the average width of the joint.

For the smaller cracks, the asphalt is heated to a temperature of only 100° and the pouring pot is used with a smaller jet at the end. Great care must be taken not to overheat this material, as it is highly inflammable. Grits are not used in this work, but after the crack has been filled, sand may be sprinkled on top to prevent picking up.

For filling pits and where scaling has occurred, and other defects, experiments in Connecticut appear to prove that asphalt has longer lasting qualities than tar; but the light grade, such as 65% asphalt, is slow in curing, and in warm weather will pick up on the tires of steel-tired vehicles. The same results from using the medium grades of ordinary commercial binders, while the heavier grades are unsatisfactory because of the difficulty of application in thin layers, and the tendency to chip in cold weather.

Connecticut has had the best results with cut-back asphalt, high in volatile oils, which cures quickly and prevents picking up or tracking of the material.

Before applying the material, the area of the pavement should be cleaned of all foreign materials; asphalt will separate and ball if dust is left in the pit holes. The material, warmed to 100° F., is applied to the area to be treated with a hand pouring pot, and is spread with a rubber-edged squeegee so that the distribution is about 0.1 of a gallon to the square yard. As the material chills rapidly on contact with the cool pavement surface, squeegee work should immediately follow the pouring. A sloppy, unsightly condition will result if the material is squeegeed in a haphazard manner. Following this, about 12 lbs. per square yard of a good grade of screened sand is applied uniformly. In some cases the sand is mixed with the cut-back asphalt in a mechanical mixer before applying, in the proportion of 18 gallons of asphalt per cubic yard of sand, which material is spread to the desired thickness and hand tamped. This method is used more generally during the cold months.

For surface defects of sufficient depths, Amiesite sand mix has given excellent satisfaction. Where a slab has settled, requiring building up a considerable distance, a standard Amiesite with a seal coat of Amiesite sand mix, has proved satisfactory.

Ocean Beach Esplanade, San Francisco

The citizens of San Francisco in November, 1927 voted $9,380,000 for the construction of 15.62 miles of boulevard as recommended by city engineer M. M. O'Shaughnessy. He asked that the funds be made available at the rate of $2,500,000 on February 1 and July 1, 1928 and January 1, 1929 and the remaining $1,880,000 on July 1, 1929. This would permit completion of the boulevard as planned, including paving, by June 1930, allowing sufficient time for the fills to settle in the interim.

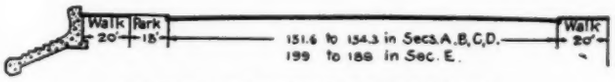
The first block of bonds were sold on February 27, 1928, and preparation made for the construction of a number of the boulevard projects. Owing to the fact that no land or right-of-way had to be purchased for the Ocean Beach Esplanade, work on this was under way in advance of the others and proceeded satisfactorily, Mr.

O'Shaughnessy in his annual 1928 report stating that the contract for this work probably would be completed by April of this year.

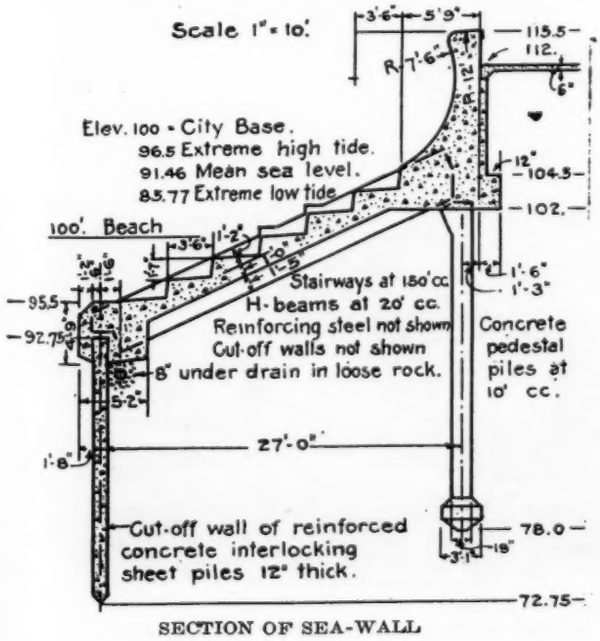
This contract, for 2,232 feet of esplanade along the ocean frontage of Golden Gate Park, was awarded on March 2, 1928 to the Healy-Tibbitts Construction Co. for the estimated amount of $329,948. A second contract for the estimated sum of $90,000 was to be let later for paving the adjacent area.

As shown by the accompanying plans, this improvement consists of a roadway pavement from 151.6 feet to 199 feet wide in the different sections, with a 20-foot walk on the land side and a 15-foot parking strip and 20-foot walk on the ocean side. This is protected by a concrete sea wall with a stepped slope and continued in a vertical wall rising 3.5 feet above the outer sidewalk, or 24 feet above mean sea level. The sea wall is supported by a series of concrete pedestal piles 18 inches diameter and 24 feet long, placed at 10-foot intervals center to center along a line directly under the vertical wall; the outer end of the sloping part of the sea wall being supported by a cut-off wall of reinforced concrete interlocking sheet piles 12 inches thick and 20 feet long.

The pavement will consist of an 8-inch concrete base with 1½ inches of asphalt binder and 1½ inches of asphaltic concrete wearing surface. The wearing surface and binder are of the thickness and grade that have proven most satisfactory for conditions in San Francisco. The concrete specifications have been revised to fix the amount of cement at six sacks per cubic yard of finished concrete, to especially stress the quality and grading as to size of the rock and sand, and to fix a definite water content. In fills or other places liable to settlement, a temporary macadam pavement 8 inches thick with oiled surface is laid by the city, with its surface at such elevation that it will serve as a base for the concrete which will be laid after the fill has been thoroughly compacted by a season or more of weathering. In all the boulevards under construction, conduits are being installed for lighting and for the various traffic signals, and electroliers are being erected.



TYPICAL SECTION OF ESPLANADE



SECTION OF SEA-WALL

A Million Dollar Block of Concrete

New York anchorage of Hudson River bridge will be a 214,000-ton block of concrete. Some construction details

The Hudson River Bridge now under construction connecting the upper part of New York City with New Jersey is the biggest thing of its kind under construction in this country. The central span of 3500 feet is by far the longest that has ever been built; the four cables of 36 inch diameter are by far the largest ever built; each of the towers will rise 670 feet above water level and will contain about 80,000,000 pounds of structural steel encased in reinforced concrete; the cables will contain 106,000 miles of steel wire and will weigh 28,500 tons and will cost, erected, over $12,000,000. They will carry a load of 168 million pounds.

At the New Jersey end the cables are anchored into the trap rock of the Palisades, tunnels having been blasted back into the bed rock, in which the cables will be carried and anchored and the tunnels filled with concrete. On the New York side bed rock was not available for such anchorage and it has been necessary to construct an enormous block of concrete to serve as anchorage for this end of the bridge. This block of concrete is believed to be the largest so far ever constructed. It will be 320 feet long, 220 feet wide, and 100 feet high above bed rock, to which it will be fastened, and will weigh 214,000 tons. It will be twice as large as the anchorage of the Camden-Philadelphia bridge, which is at present the largest in the world. Each of the four cables will be inserted in this concrete block, the ends being spread into five units like five fingers, each of these fastened to I-bolts and these in turn to large steel beams which are imbedded in this mass of concrete. This anchorage will cost over a million dollars.

This anchorage lies between the New York Central railroad and the Hudson river on one side and Riverside Drive on the other. Neither of these could be obstructed by any of the construction plant or operation. This condition, together with the opportunity offered for the most economical method of construction because of the enormous amount of concrete involved, were considered in designing the plant for building the anchorage.

The sand and gravel aggregate and cement are brought by barges to a dock at the Hudson river, removed by cranes and derricks, and placed near

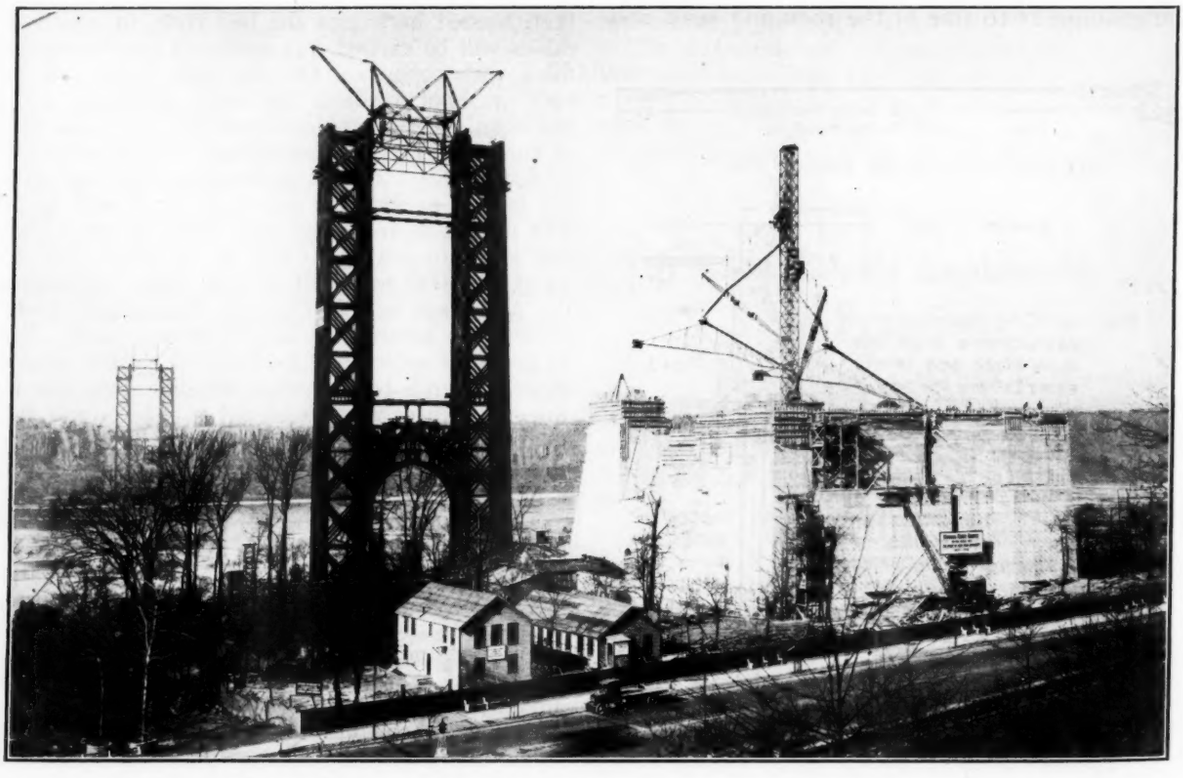
a temporary tunnel constructed under the dock. In this tunnel has been installed a belt conveyor on to which the sand and gravel are fed; which conveyor in turn feeds the aggregate onto two other conveyors leading to the mixing building. The cement also is unloaded from barges onto the dock and thence onto another conveyor which runs parallel to and beneath the gravel conveyor and unloads the cement into the same mixing shed. In this shed the sand, gravel, and cement are weighed out and fed to two mixers at the rate of two tons a minute. From these mixers the concrete is discharged onto another conveyor which runs to the center of the anchorage under construction and there discharges it into a bucket holding 4 tons of concrete. This bucket is raised in a tower and fed into chutes suspended from the tower and by them discharged into the forms; the chutes being adjustable to discharge throughout an entire circle.

The belt conveyor system is similar to the one described in the issue of PUBLIC WORKS for October 1925 and was designed by the same engineer who designed the Wanaque plant, Captain C. M. Mitchell, president of the Conveying Weigher Company, which built the conveying system, using in it conveyor belt made by the Manhattan Rubber Mfg. Company. This method of conveying mixed concrete by belts is believed to have been used first in 1920 in constructing a dam for the Stamford, Connecticut, water works. Since then it has been employed for a number of structures using large quantities of concrete, including the dam for the New Haven Water Works at North Branford, Connecticut; the Conowingo dam at Havre de Grasse, Maryland, and some others.

Ready-Mix Plants

Plants for the sale of ready-mixed concrete are increasing rapidly and a few weeks ago it was estimated that there were approximately 100 in operation in the country. Among the advantages claimed for ready-mixed concrete is that of factory production over hand work, and of a large permanent plant over several small temporary field plants. As the materials are handled by machinery from the time they leave the cars until they are delivered to the trucks as mixed concrete, the amount of hand labor and the number of times the materials must be handled are decreased. The operators at the central plant become more skillful and capable of producing a better and more uniform quality of concrete than the average field operators. Also, a properly equipped central plant is generally capable of measuring materials more accurately and obtaining more uniform proportions than field plants. There is also the elimination of the expense of moving mixing equipment from job to job, and of the waste of cement, aggregate and sacks, common to field work.

There are some difficulties attached to this procedure, most of them being connected with the transportation. Regular schedules of delivery to each job must be maintained, which requires ample and dependable trucks. Concrete has a tendency to segregate when hauled in trucks, the water and fine material floating to the top and the sand and coarse materials compacting on the bottom. This has been overcome



NEW YORK ANCHORAGE AND TOWER OF HUDSON RIVER BRIDGE
New Jersey tower in background. Taken February 7. Towers about 600 ft. high

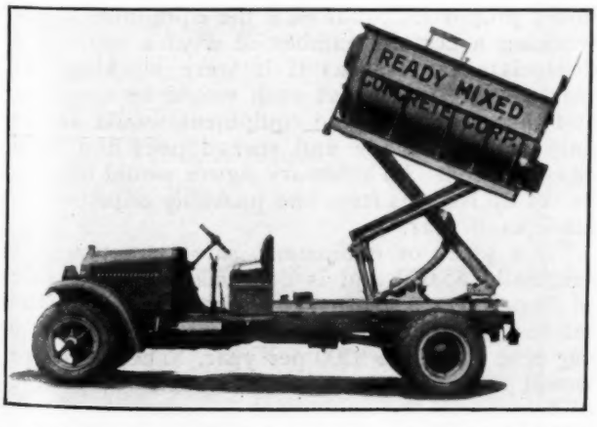
to some extent by using less water in the mix or by application of certain chemicals and by using pneumatic tires. Considerable difficulty has also been experienced with the concrete compacting and sticking to the sides of the body, making dumping difficult; which has been met in some cases by using bodies without any angles, but with curved surfaces between the bottom and the sides and end, a type sometimes called the "bathtub" type. (Such a body was described by us in the issue of December, 1927.) Some truck manufacturers offer bodies with high-lift hoists which permits chuting the concrete when required or pouring directly into concrete forms at a height of approximately 8 or 9 feet above the ground, or dumping into elevated containers for serving the wheelbarrow crew.

An adequate ready-mix plant is expensive, and will be financially successful only when it can obtain enough business to pay all overhead and keep the employes busy every day. But in localities where enough business within transportation distance will be obtainable for several years to come, such plants will probably be established in the near future.

Commercial Ready-Mixed Concrete for County Road

Concrete from a commercial mixing plant was used last summer in the construction of an 18-foot pavement on Pumphouse Road, near Birmingham, Alabama. This road carries a traffic of about 200 vehicles an hour and is the only direct connection between Birmingham and valleys on the other side of the mountain. The 18-foot pavement, 8 inches thick at the edges and 6 inches at the center, extended over a section three miles long, about one mile of which was so located that it was impossible to detour the traffic nor was the road wide enough to permit traffic to pass by the full 18-foot strip, and in this section the concrete was laid half at a time in two 9-foot strips, wooden forms being used along the center with holes bored through them to receive ½-inch tie bars which were placed four feet center to center.

The concrete was purchased from the Sloss-Sheffield commercial mixing plant in Birmingham and was hauled a maximum distance of 5¾ miles, the longest haul requiring eight trucks, each carrying two or three yards of concrete, which were furnished by the Sloss-Sheffield Company. The average hauling time was 35 minutes, but there was much delay in transit due to traffic and occasionally the time occupied was considerably longer. In spite of this time in the trucks, no trouble was experienced in dumping, nor because of hardening of the concrete before it could be placed and finished. In spite of delays caused by the half-at-a-time method of conducting the work, it was completed in good time and at a smaller cost than would have been possible had it been necessary to set up a proportioning plant and invest in the necessary hauling and mixing equipment.



HIGH-LIFT, BATH-TUB BODY, CONCRETE TRUCK

The concrete was cured with a surface application of calcium chloride. It was struck off and finished by hand and, as the cement company furnished the trucks, the investment in equipment was exceptionally low.

The traffic during construction was confined to alternate one-way traffic, and as there were several bends in the road, and accordingly it was not possible for the traffic officer at one end to see the one at the other, the method was employed of giving a green flag to the last vehicle allowed to go in one direction, which flag was surrendered to the officer at the other end when this vehicle passed him and was given by him to the last vehicle going in the opposite direction.

Reinforced Tar Macadam Road

A reinforced tar macadam road was laid in Somerset, England, two or three years ago and was described by J. Johnson, district surveyor, in a paper before the Association of Somerset Surveyors a few weeks ago. Mr. Johnson stated that prior to 1926 considerable difficulty had been experienced in keeping the surface of Cemetery Hill section in good repair owing to the movement under the weight of traffic of the top four inches of the tar construction. After one or two attempts at preventing this trouble it was decided to resurface the hill with tarred limestone reinforced with No. 9 fabric.

In carrying out this reconstruction, the road was scarified and rolled, after which a bottom layer of tarred limestone of 2-inch gauge was spread to a thickness of about 1½ inches and lightly rolled with a ten-ton steam roller. The reinforcement, which was supplied in rolls 240 feet long by seven feet wide, was placed over this layer with the longitudinal wires parallel with the curb, successive rolls lapping three inches. The end was spiked down with pointed steel spikes driven into the ground and, as the reinforcement was unrolled, other spikes were driven down at such intervals as seemed necessary. Difficulty was experienced in driving the spikes and making them stay in place in the stone base, and this was finally effected by the use of heated tar poured around each spike. When about half the width of the roadway had been so covered, the tarred material was laid on top to a thickness of about 3 inches and compacted with a steam roller in the ordinary way.

At the time Mr. Johnson read his paper this road

had been down two and a half years and he reported it as being practically free from corrugation and the general condition of the surface as good. He said that the cost was about 50c per square yard above that of an ordinary tar macadam surface.

Engineers' Estimates

"It will doubtless be admitted by thinking architects, engineers, and constructors, that estimating as now practiced is about the most inaccurate, opportune and nebulous procedure ever conducted under the mantle of science." This statement is made by the "Highway Builder" (the official organ of twelve associations of contractors), after calling attention to the cost of the Moffatt tunnel which was two and a half times the engineers' estimate, "the Hudson tunnel costing more than six times the amount originally estimated, the Muscle Shoals dam costing more than four times the amount originally estimated, the Delaware bridge vastly exceeding original estimates, and innumerable other projects which might be mentioned." The "Highway Builder" then states that the problem of estimating should be attacked through joint and coordinated work by the various national associations of architects, engineers and contractors, through a central agency. "By the same token, more tolerance upon the part of engineers in rejecting bids at variance with their estimates would appear to be indicated."

Depreciation of Contractors' Equipment

Report of committee of American Road Builders Association, giving tables showing working days per year in the several states, and the average useful life and annual depreciation of each of more than two hundred items.

A committee on Depreciation of Contractors' Equipment was appointed last year by the directors of the American Road Builders' Association with three purposes in mind:

First—To have the information so that fair rental rates might be set up by the contractor for his equipment for use in connection with the cost-plus-a fee contracts; such rental rates, however, not to include profit. If a profit on the equipment is to be added, an adjustment in the rate will be necessary. Also, that the contractor might set up a rental rate to use on contract work so that sufficient money would be set aside to pay for the depreciation, interest, insurance and operation of the equipment.

Second—To give public officials information on the value of machines so that they may evaluate the list of plant submitted with the bidder's questionnaire. Also, to give public officials information for setting up rental rates for equipment owned by the states or their subdivisions, used principally on maintenance work, so that the equipment charges will be represented in the cost of the work.

Third—To provide information for bankers and others who have credit transactions with the construction companies.

This committee, through its chairman, W. A. Van Duzer (Deputy Engineer Executive, Pennsylvania Dept. of Highways) reported at the convention this year, giving a schedule of equipment depreciation, by percentages, which it offers as a tentative working basis subject to change when further data are available; also lists of the working days for grading and for paving in each of the states. The latter are, of course, of general interest to contractors, and are given here for use in calculating daily, weekly or monthly deprecitaion for any given location of job.

The committee recommended that it be continued as a permanent committee to work with a similar committee of the Associated General Contractors.

The report recognizes a distinction between depreciation and obsolescence and two classes of obsolescence—one which is going on continuously, and the abrupt change from one type of equipment to another, which it calls "sub-obsolescence." "It has been very difficult up to this time to place a depreciation figure upon the majority of road equipment, due to the great changes which have taken place almost yearly in the construction industry. Equipment which is considered efficient one year would be discarded the next season on account of different methods employed on larger production by the use of other equipment.

"We believe the industry is sufficiently established at this time so that sub-obsolescence due to the inadequacy of equipment will be reduced to a minimum. This factor has not been considered in setting up the proposed rental schedule.

"The Committee of the Associated General Contractors agrees on three methods of depreciation:

1. The unit of time basis—charge off so much depreciation for each hour, day or month used.
2. The unit of work basis—charge off depreciation according to the work done.
3. Contractor's equipment or job method.

"In applying the rental schedule, the question arises whether the rental rates for 120 working days a season should be twice as much as the rental rates for the 240-day season. Unquestionably equipment depreciates even if not used, but there is a question whether it depreciates in direct proportion; that is, if the equipment is not working a certain number of days a year, if it depreciates as fast as if it were working. It would seem to us that such would be the case, and that repairs to the equipment would be the only addition made and spread over the total days worked. An arbitrary figure would have to be set up for this item and probably adjustments made each year.

"If a piece of equipment, say a tractor, cost originally $5,000 and is depreciated at the rate of 20 per cent a year, which would be $1,000, the interest on the initial investment of $5,000 at 6 per cent would be $300 per year. The insurance would probably be around $50 a year, irrespective of how much the equipment is operated. There would be a fixed charge of $1,350 a year, and if

Working Days Per Year

Exclusive of Sundays, holidays and bad weather.

State	Grading	Paving
Alabama	240	240-300
Arizona	200-300	200-300
Arkansas	300	300
California	155-300	120-300
Colorado	No data	No data
Connecticut	200-240	125-155
Delaware	220	160
Florida	240	240 up
Georgia	300	300
Idaho	120-200	80-120
Illinois	180-240	120-135
Indiana	160-175	120-140
Iowa	175	125
Kansas	200	140
Kentucky	175	100
Louisiana	225	225
Maine	140	110
Maryland	180-240	140
Massachusetts	225	150
Michigan	180	130
Minnesota	150	100
Mississippi	240	160
Missouri	No data	No data
Montana	No data	100-120
Nebraska	250	225
Nevada	240-300	150-175
New Hampshire	140	100
New Jersey	No data	No data
New Mexico	No data	No data
New York	160	150
North Carolina	200	200
North Dakota	150	180
Ohio	No data	No data
Oklahoma	225-240	225-240
Oregon	No data	No data
Pennsylvania	190	120-140
Rhode Island	190-200	140-150
South Carolina	210-240	180-240
South Dakota	130-165	110-140
Tennessee	190	175
Texas	240-300	180-240
Utah	170-180	170-180
Vermont	155	115
Virginia	180-210	150-180
Washington	No data	No data
West Virginia	No data	160-200
Wisconsin	140-150	110
Wyoming	200	140-160

Annual Depreciation of Contractors' Equipment

Tentative scedule recommended by American Road Builders Ass'n.

ITEMS OF INTEREST	Average Useful Life Years	Day's Work	Annual Depreciation percent
Automobiles, light	2	460	50
Automobiles, medium	3	690	33+
Automobiles, heavy, high grade	4	920	25
Backfillers, light	3	380	33+
Backfillers, medium	4	505	25
Backfillers, heavy	5	630	20
Ballast spreader cars	10	300	10
Barbenders	3	530	33+
Barcutters	3	530	33+
Batchboxes	3	350	33+
Batch inundators	3	305	33+
Batch measuring devices	3	350	33+
Batcher plants, all steel demountable	4	470	25
Batcher plants, steel fr. wood bin	4	470	25
Batcher plants, wood frame and wood bin	2	235	50
Bin frames, steel	5	585	20
Bins, only, steel	5	585	20
Bins only, wood	2	235	50
Blacksmith shop outfits	4	770	25
Boilers, locomotive	7	700	14+
Boilers, upright	7	700	14+
Buckets, cable way	4	410	25
Buckets, concrete	3	310	33+
Buckets, clam-shell	4	445	25
Buckets, drag-line	4	430	25
Buckets, orange peel	4	400	25
Buildings, job office, steel standard	3	900	33+
Bulldozers, for tractor	2	200	50
Bunkers, stone portable, with screen	3	345	33+
Cableways, cable only	3	395	33+
Cableway carriages	5	660	20
Cableway towers, steel	4	530	25
Cableway towers, wood	2	265	50
Cars, batch box, steel	4	470	25
Cars, boarding and tool	7	1260	14+
Cars, concrete	4	410	25
Cars, dump, steel	7	820	14+
Cars, dump, wood	5	585	20
Cars, flat, steel	8	1150	12½
Cars, flat, wood	6	865	17—
Cars, hopper, steel	9	800	11+
Carts, concrete	3	250	33+
Channelers, rock machine	4	350	25
Concrete machines, pneumatic	4	280	25
Compressors, motor truck unit	5	570	20
Compressors, portable, electric	6	630	17—
Compressors, portable, gas	4	420	25
Compressors, portable, steam	6	630	17—
Concrete Spouting Equipment:			
Concrete buckets	3	310	33+
Hoppers	3	310	33+
Spouts and chutes	2	210	50
Towers, steel boom and counter-weight	5	560	20
Tower spouting plant complete	4	415	25
Conveyors, elevating, belt, portable	3	250	33+
Conveyors, elevating, belt, stationary	4	350	25
Cranes, motor trucks, mounted	4	430	25
Cranes, crawler, electric, light	5	540	20
Cranes, crawler, electric, medium	6	650	17—
Cranes, crawler, electric, heavy	8	865	12½
Cranes, crawler, gas, light	4	480	25
Cranes, crawler, gas, medium	5	600	20
Cranes, crawler, gas, heavy	6	720	17—
Cranes, crawler, steam, light	5	600	20
Cranes, crawler, steam, medium	6	720	17—
Cranes, crawler, steam, heavy	8	960	12½
Cranes, locomotive, gas	7	850	14+
Cranes, locomotive, steam	10	1240	10
Crushers, rock, portable	4	460	25
Crushers, rock, stationary	6	690	17—
Cutting and welding outfits, portable	4	320	25
Derrick cars, bridge, builders, complete	10	690	10
Derrick crabs, hand	6	720	17—
Derrick crabs, power	4	480	25
Derricks, guy, steel	8	1320	12½
Derricks, guy, wood	4	660	25
Derricks hand, circle swing	4	480	25
Derricks, stiff log, steel	8	1320	12½
Derricks, stiff log, wood	4	660	25
Drag lines, electric, light	5	540	20
Drag lines, electric, medium	6	650	17—
Drag lines, electric, heavy	8	865	12½
Drag lines, gas, light	4	480	25
Drag lines, gas, medium	5	600	20
Drag lines, gas, heavy	6	720	17—
Drag lines, steam, light	5	600	20
Drag lines, steam, medium	6	720	17—
Drag lines, steam, heavy	8	960	12½
Drills, electric rock	3	320	33+
Drills, air, tripod	4	400	25
Drills, air, drifter	3	315	33+
Drills, jack hammer	3	330	33+
Drills, tunnel carriage	5	300	20
Drills, well, traction	6	360	17—
Drill sharpeners, pneumatic	5	660	20
Electric Tools:			
Boring machines	3	360	33+
Drills, hand	3	360	33+
Grinders	3	360	33+
Hammers	2	240	50
Saws, hand	2	240	50
Elevators, buckets, stationary	4	460	25
Elevators, cage, steel tower	5	580	20
Engines, only, gas	5	510	20
Engines only, oil	5	850	20
Engines only, steam	10	920	10
Excavators cableway, complete, except power	3	345	33+
Finishing machines	3	350	33+
Floats, bridge, steel	4	470	25
Forms, steel, curb and gutter	3	420	33+
Form, steel, road	3	350	33+
Forms, steel, wall	4	300	25
Forms, steel, tunnel	2	250	50
Gin poles, steel	5	825	20
Graders, blade, road, light	2	230	50
Graders, blade, road, medium	3	350	33+
Graders, blade, road, heavy	5	600	20
Graders, blade, road, power, light	2	230	50
Graders, blade, road, power, medium	3	350	33+
Graders, blade, road, power, heavy	4	500	25
Graders, elevating	4	550	25
Graders, form (subgrader planers)	3	360	33+
Gravel washers (see washers).			
Hammers, air (See pneumatic tools			
Hammers, pile (See pile hammer)			
Hoisting units, chain	5	825	20
Hoisting units, drum, electric	7	900	14+
Hoisting units, drum, gas	5	650	20
Hoisting units, drum, steam, with boiler	8	1020	12½
Hoisting units, post, electric	4	660	25
Hoists, only, drum no power	10	1650	10
Hoists slews, steam	10	1650	10
Hoists slews, electric	5	825	20

ITEMS OF INTEREST	Average Useful Life Years	Day's Work	Annual Depreciation per-cent
Hydraulic giants	7	755	14+
Inundators (see batch inundators)			
Jacks, hydraulic	6	990	17—
Jacks, screw	5	880	20
Lead melting furnaces	5	540	20
Loaders, bucket, stationary	6	460	17—
Loaders, bucket, crawler	4	350	25
Loaders, bucket, portable	5	300	20
Locomotives, battery	4	500	25
Locomotives, gasoline, light	4	470	25
Locomotives, gasoline, medium	5	585	20
Locomotives, gasoline, heavy	6	700	17—
Locomotives, steam, industrial light	7	770	14+
medium	8	880	12½
Locomotives, steam, industrial heavy	9	990	11+
Locomotives, steam, railroad type	12	1225	8+
Mixers, concrete, A. G. C. Std.			
Building, electric	4	500	25
Building, gas, light	2	250	50
Building, gas, medium	3	375	33+
Building, gas, heavy	4	500	25
Building, steam	5	550	20
Paving, gas (21-E obsolete)	4	450	25
Paving, steam (21-E size obsolete)	4	500	25
Truck mounted units	3	360	33+
Mixers, mortar, portable	3	360	33+
Motors, electric, small	4	480	25
Motors, electric, medium	5	600	20
Motors, electric, large	6	720	17—
Mowers, right of way	3	350	33+
Oilers, road, tank wagon, steel	6	700	17—
Pile drivers, steam outfit on skids	6	600	17—
Pile drivers, railroad outfits	10	650	10
Pile hammers, steam or air, light	3	270	33+
Pile hammers, steam or air, medium	5	450	20
Pile hammers, steam or air, heavy	7	560	14+
Pipe, galvanized	4	460	25
Pipe, black	4	460	25
Plows, furrow or rooter	3	340	33+
Pneumatic Tools:			
Backfill tampers	3	300	33+
Borers, wood	3	300	33+
Calking and chip hammers	3	300	33+
Clay diggers	3	300	33+
Drills, jack hammer	3	330	33+
Holders-on	4	400	25
Pavement breakers	3	300	33+
Riveters	3	300	33+
Saws, hand	3	300	33+
Pumping Units, Portable:			
Centrifugal, electric	4	470	25
Centrifugal, gas	3	350	33+
Diaphragm, electric	4	470	25
Diaphragm, gas	3	350	33+
Piston, electric	4	470	25
Piston, gas	3	350	33+
Pumping Units, Stationary:			
Centrifugal, electric	5	585	20
Centrifugal, gas	4	470	25
Centrifugal, steam	5	585	20
Piston, electric	5	585	20
Piston, gas	4	470	25
Piston steam	5	585	20
Pump, only, centrifugal	6	600	17—
Pumps, only, impulse	8	720	12½
Pumps, only, piston	6	650	17—
Rails, steel	8	1060	12½
Riveters (See pneumatic tools):			
Rollers, concrete finishing, steel	5	585	20
Rollers, road, gas	7	800	14+
Rollers, road, steam	9	1100	11+
Rooter graders, wheel	4	470	25
Saw and wood workers, steel frame	5	700	20
Saws and wood workers, wood	3	420	33+
Scarafier attachments	2	235	50
Scarafiers, drag, all steel	3	350	33+
Scarafiers, grader type	3	350	33+
Scarafiers, block, steerable	4	470	25
Scrapers, fresno	2	260	50
Scrapers, maney	3	390	33+
Scrapers, morman	2	260	50
Scrapers, rotary	2	260	50
Scrapers, slip	1	150	100
Scrapers, wheel	3	360	33+
Screens and bunkers	3	350	33+
Screen only	3	345	33+
Shores, adustable	3	480	33+
Shovels, crawler or wheel, electric, light	5	540	20
Shovels, crawler or wheel, electric, medium	6	650	17—
Shovels, crawler or wheel, electric, heavy	8	865	12½
Shovels, crawler or wheel, gas, light	4	480	25
Shovels, crawler or wheel, gas, medium	5	600	20
Shovels, crawler or wheel, gas, heavy	6	720	17—
Shovels, crawler or wheel, steam, light	5	600	20
Shovels, crawler or wheel, steam, medium	6	720	17—
Shovels, crawler or wheel, steam, heavy	8	960	12½
Shovels, railroad, steam	9	1080	11+
Shovels, tunnel	3	300	33+
Stone spreaders, hopper wagon	4	320	25
Stone spreaders, steel box	4	320	25
Subgrader (see graders)			
Switches, portable	3	360	33+
Switches, stationary	4	480	25
Tool carts, steel	4	700	25
Track, industrial portable	4	600	25
Tractors, very light	2	240	50
Tractors, light	3	350	33+
Tractors, medium	4	470	25
Tractors, heavy	5	600	20
Trailers, dump, steel	5	540	20
Trailers, dump, wood	4	430	25
Trailers, platform, wood	4	430	25
Trailers, drop platform, heavy duty	5	420	20
Towers (See elevators and concrete equip.):			
Trenching machines, gas, light	3	300	33+
Trenching machines, gas, med.	5	500	20
Trenching machines, gas, heavy	7	700	14+
Trenching machines, steam light	5	500	20
Trenching machines, steam, medium	6	600	17—
Trenching machines, steam, heavy	8	800	12½+
Trucks, general purpose, light.	2	375	50
Trucks, general purpose, med.	3	560	33+
Trucks, general purpose, heavy high grade	4	750	25
Trucks, dump, light	2	235	50
Trucks, dump, medium	3	350	33+
Trucks, dump, heavy, high grade	4	470	25
Turntables, industrial rwy.	4	470	25
Turntables, truck	3	350	33+
Wagons, dump, steel	5	600	20
Wagons, dump, wood	4	480	25
Wagons, farm, heavy	4	480	25
Wagons, farm, light	3	360	33+
Wagons, tank or sprinkler, steel	5	600	20
Wagons, tank or sprinkler wood	3	330	33+
Wagon Loaders (See loaders):			
Washers, gravel	3	345	33+

the equipment were operated 120 days, the cost per day would be over $11, exclusive of repairs and operation costs. If the equipment operated 240 days, there would be a cost of a little over $5.50 per day for the above named items, but probably an increased cost in repairs."

Width of Right of Way

"More care should be used in determining the width of the right-of-way for a road to be improved," said George F. Gault, surveyor of Wayne County, in a paper before the 15th Annual Purdue Road School, dealing with the construction of penetration macadam roads. In Indiana most of the road building is done under the "Three Mile Road Law," one of the provisions of which is that there shall be three viewers, one of which shall be the engineer. These viewers file a report which includes not only plans and specifications for the work, but also width of right of way, alignment of road, and width of

pavemet to be built. Said Mr. Gault: "In a great many cases we permit structures which can easily be moved back, to cause us to recommend a width of right-of-way which is too narrow to permit proper grading and draining. As the engineer usually prepares the greater part of this report, I feel that he is largely to blame for this condition. Before preparing any part of this report, I think we should make a complete survey of the proposed improvements, including accurate cross sections, and provide for a width of right-of-way that will allow for not less than 5 feet beyond the toe of the slope in the deepest fill, or 5 feet beyond the top of slope in the deepest cut. The width of the right-of-way will be different on different sections of the road to meet the situation."

In locating and planning the right of way, considerable difficulty is often encountered in connection with the surface drainage of the land on each side of the road, which at first might seem to have no connection with the improvement. Mr. Gault suggested that "each land owner who might have any drains either across the road or parallel with the road to be built, and within the limits of the proposed right of way, be interviewed before the specifications are finally completed and an agreement made as to how the existing drains are to be taken care of during the progress of the work, and what the final arrangement will consist of. Any connecting or cross road should be considered from a drainage standpoint as well as from the standpoint of the grade."

Hospital Sewage Treatment Plant

New sewage treatment plant for county tuberculosis hospital at South Braintree, Massachusetts

By Howard E. Bailey*

A new sewage treatment plant has recently been constructed to serve the Norfolk County Hospital at South Braintree, Mass. The plant consists of settling tanks, dosing tank and sand filters designed to serve 200 persons. Among other interesting features of the work are measurements taken on the flow of sewage.

OLD TREATMENT PLANT

The Norfolk County Hospital was built about eight years ago. The sewage from the hospital is discharged through a 6-inch vitrified pipe sewer which extended formerly to a system of leeching cesspools at the westerly end of the hospital property, adjacent to a swamp bordering on the Cochato river. The leeching surface of these cesspools became so clogged that overflow pipes were installed to take care of the flow of sewage. Soon the condition of the cesspools and the surrounding ground became such that the construction of a new plant was deemed advisable.

*Assistant engineer, Metcalf & Eddy, Engineers, Boston, Mass.

The quantity of sewage to be expected from the hospital was problematical. The only data available indicated that during the three summer months the water consumption ran as high as 23,300 gallons per day, the hospital accommodating 100 patients and 45 resident employees. The water was used for culinary purposes, toilet, bathroom, laundry, ice machine and boilers, but the blow-off from the boilers and the ice machine waste pipe were not connected with the sewer system. The plant was designed to serve 200 persons assuming a flow of sewage of 100 gallons per capita per day.

NEW TREATMENT PLANT

The new sewage treatment plant consists of duplicate settling tanks, a dosing tank and four open sand filter beds with underdrains and necessary connecting sewers and piping, as shown in Fig. 1.

The existing sewer was intercepted just above the line of cesspools and the flow of sewage was diverted to the new treatment plant site. A distribution manhole was built to divide the flow equally between the two tanks. The invert of this manhole was placed at such an elevation that the outlets are submerged at all times to avoid trouble from clogging.

The settling tanks were constructed of concrete in two units to be operated in parallel, with separate inlets provided with gates so that one unit may be shut off for cleaning while the other remains in use.

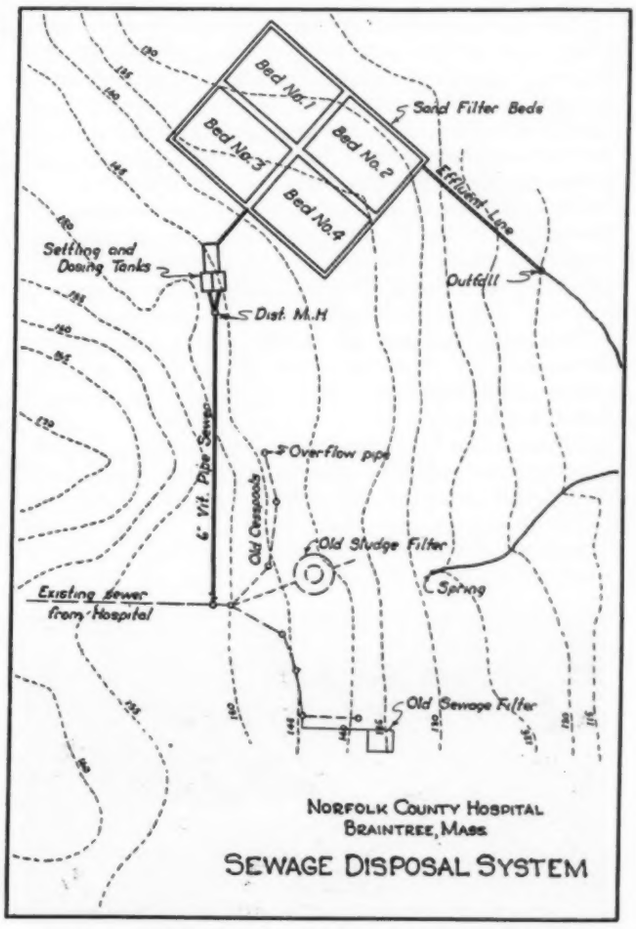


FIG. 1—GENERAL PLAN OF SEWAGE DISPOSAL PLANT

LAYOUT OF SAND FILTER BEDS

The tanks were built below the surface of the ground and provided with inlet and outlet pipes and entrance manholes. The working capacity of the tanks is approximately 20,000 gallons.

The effluent from the settling tanks discharges into a dosing tank built as a part of the settling tank structure. This dosing tank is provided with an automatic siphon and has a capacity of approximately 10,000 gallons.

Sewage would be dosed on the filters about twice a day under capacity conditions. The frequency of dosing was found to be about once per day for 145 persons when the plant was put in operation.

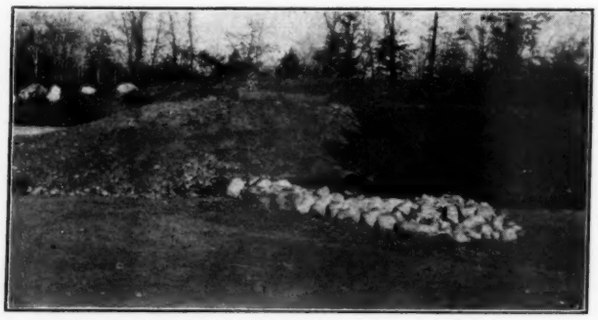
The sewage filters, of which there are four, occupy an area of approximately one-half acre, equivalent to 400 persons per acre under capacity conditions. The average rate of operation would be about 40,000 gallons per day per acre on the entire area, based on the above figures.

The site for the filters was levelled to form a subgrade, and in this trenches were dug containing the effluent collecting tile pipe system constructed with open joints surrounded with graded gravel. Sand having an effective size ranging from 0.20 to 0.30 and a uniformity coefficient of about 2.65 was used in constructing the filter beds.

The effluent from the dosing tank is discharged through a 10-inch pipe line into the distribution manholes placed between each pair of filters. These manholes are equipped with outlet pipes and shear gates so that any bed may be dosed as desired.

The effluent from the sewage filters is conducted through a tile pipe line down the slope to a water course, in which it will flow to the swamp adjacent to the river.

Sludge may be drawn periodically from the settling tanks by opening gate valves in the sludge line. A 10-inch vitrified tile pipe drain conducts the sludge to one of the filter beds for drying. This filter bed is cut out of regular service during the short period when the sludge is drying.



VIEW OF DISTRIBUTING MANHOLE AND PAVED INLET

No difficulty was encountered in constructing the plant. The total cost of the construction work was $16,394.90. Sand for the filters was obtained from a pit less than a mile from the site. Ground water was encountered on only one section of the filters.

OBSERVED FLOW OF SEWAGE

Observations made on the flow of sewage covered a period of about three weeks. The flow of sewage was found to vary from a minimum of 100 gallons per hour to 700 gallons per hour. Night flows in general were about 175 gallons per hour. On days when the laundry was in operation, the flow sometimes reached as high as 700 gallons per hour. These records show that the average flow of sewage to be expected during the months of July and August was 315 gallons per hour or 52 gallons per capita per day.

New Ornamental Street Lamp

A light globe that is distinctly unusual has been developed by the Westinghouse Electric and Manufacturing Company for Riverside, Calif. It was especially designed to harmonize with the mission bell on the Indian "rain cross"

BELL LIGHT GLOBES IN RIVERSIDE

in that city. The globe is bell-shaped, and is made of rectilinear glass, is dustproof and bugproof, is 15" high, 16" in diameter, and has a shipping weight of 30 lbs.

While exceptionally pleasing to the artistic sense of the beholder, the globe sacrifices no efficiency to gain this end.

Power Shovel Work in New Mexico

Up to January 1, 1929, 162,711 cubic yards of unclassified excavation had been removed in the construction work on U. S. Route 485, Rio Grande Canyon, New Mexico. The cost of labor and materials on this totalled $25,397.98, an average direct cost for operation of 15.6 cents per yard. The depreciation allowance of 3.4 cents per yard makes the total cost 19 cents per cubic yard.

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A. PRESCOTT FOLWELL, Editor
W. A. HARDENBERGH, Associate Editor

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Engineers and Highway Safety

Loss of life and property in automobile accidents has long been a most serious feature of highway traffic, and does not seem to be decreasing. Figures for Pennsylvania showed 185 deaths in January, which was ten percent more than in December. Of these, 78 occurred at intersections, 27 were due to skidding, and 9 occurred at railroad crossings. More than two thousand accidents were due to these causes.

Highway engineers have figured the saving to traffic effected by reducing length of road, grade, traction resistance, etc.; but the possibility of saving by reducing the number of accidents is seldom mentioned. If each accident involves a property loss, on the average, of $100, and a life is valued at $10,000, the January accidents in Pennsylvania would figure a total loss of more than two million dollars, or about twenty-five million dollars a year.

Of course, most of these were not due to any features of the road itself; but have engineers considered sufficiently how construction features might be employed to reduce the number of accidents? Two writers whose articles appear in this issue think that they have not. They list, as possible preventives of accidents, warning signs, center stripes, adequate sight distances, pavements neither slippery nor too rough, shoulders sufficiently wide for passing, sufficient width of roadway, protecting side ditches, providing guard fences, sufficient length of culverts, super-elevation of curves, reduced crown, wide bridges with safe approaches, elimination of railroad and highway grade crossings, and other features of design and construction.

Many of these involve considerable additions to the cost of the road, but others, such as stripes, super-elevation of curves and reduced crown would cost comparatively little. In Pennsylvania the total cost of accidents as figured above equals half or more of the sum spent on road construction; and if only ten percent of the accidents could be prevented by construction precautions such as those suggested, it would be profitable to take them if the cost of the road would not thereby be increased more than five percent. Pennsylvania is used in this estimate because the figures are at hand, but probably other states would furnish a better argument, for Pennsylvania is already taking most of these precautions. As stated by Mr. Albright, on page 144 of this issue, that state keeps curves down to a 1,000-foot radius, and grades to 6 percent; curves sharper than 2,000-foot radius are super-elevated; crowns of hard-surface roads are kept down to one inch; bridges are made wide and strong, and special consideration is given to guard fences.

Safety in use of a road is more important than comfortable riding and durability.

The Disposal of Old Automobiles

According to calculation of the American Motorists Association, 2,213,000 old automobiles were scrapped in 1928. This is one for each 50 population, approximately; or say 600 for a city of 30,000 population. While some parts of old cars are worth salvaging, these apparently are not sufficient to materially diminish the problem of disposing of them, and the outskirts of cities are being rendered unsightly by these bulky wrecks, while old quarry holes and other avail-

able hiding places are rapidly being filled with them.

It would seem as though some way could be found of salvaging this million or so tons of metal that would at least cover the cost. At present, this is a refuse disposal problem that is becoming more and more troublesome to city officials. Old bed springs used to be the bugbear of refuse disposal; but there are now nearly as many cars in this country as beds, and they do not last nearly as long. If any one has found a solution of this problem, we will be glad to pass the good news along.

Water Color Due to Swamps

In his annual report for 1928, Stephen H. Taylor, superintendent of the Water Board of New Bedford, Mass., reported that George H. Bigelow, commissioner of public health of Massachusetts, recommended that the city reduce the rather high color of its water supply by draining some of the swamps on the water shed. Mr. Bigelow stated that "the water supply of the city is of excellent quality except for the rather high color caused by the drainage from swamps in the watershed of Black brook."

The city obtains its supply from Great Quittacas pond, about 60% of the water in which is brought in by Black brook, the water shed of which is about 70 square miles. The water of this brook is highly colored, at some seasons extremely so, the cause of the color being extensive areas of swamps on the watershed, in which the water stands for a considerable time in contact with vegetable matter of various kinds. "By draining the brook in accordance with the plan proposed by the Water Department," said Dr. Bigelow, "the color of the water can be greatly reduced and a material improvement effected in the quality of the water delivered to the city. This improvement can be made gradually from time to time as convenient but should be carried through to completion at the earliest practicable time."

This was written by Dr. Bigelow early in 1928, and during the fall of that year the work of finishing the clearing of the channel of Black brook was started and was progressing well at the end of the year.

In addition to this work, the water level of Little Quittacas pond, which is connected with Great Quittacas pond, is kept as low as practicable in order to keep the water out of the surrounding swamps where it would absorb color. These swamps have been ditched to keep down the water level, and this ditching has considerably reduced the color as well as the amount of vegetable taste which appears in the water.

Also, the shores of the pond were cleared of grassy growths last year, as has been the practice for several years past.

Engineering Requirements in Highway Development

At the convention last month of the American Motorists' Association, the members adopted a program for next year embracing fifteen problems of primary importance, several of which were more or less those of design and construction.

Of these, the most important was, in their opinion, the building of secondary highways. Others were making state highways wider; by-pass routes diverting through traffic around cities; employment of traffic circles rather than intersections where possible; regional highway planning; abolition of railroad grade crossings where possible, and, where not possible, the installation of mechanical safeguards.

Efficient Road Construction in Colorado

In the construction of Federal Aid Projects 287 A-3 and 287 A-4, west of Fort Morgan on State Highway No. 2 in the State of Colorado, Edward Selander has laid 8.64 miles of pavement of exceptional quality in exceptional time, according to A. B. Collins, division engineer of the State Highway Department. Mr. Selander, having both the contracts, decided to start paving operations at the west end of the western contract and extend the work eastward to the eastern end of the other contract, where it joined a pavement already constructed. Work was begun on July 16, 1928, and the 5.087 miles of the first contract was completed August 28th, a total of 40 paving days with an average daily output of 671.4 feet per day. The second contract of 3.55 miles was begun August 30 and completed September 29; the actual paving time being 26 days, with an average daily output of 720 lineal feet of 18-foot paving.

A central proportioning plant was used, consisting of a 30 cubic yard Butler bin with volumetric measuring devices, and a ¾-yard Koehring dragline with clam shell bucket for unloading coarse aggregate from cars and for charging the bin with both fine and coarse aggregates. This plant was operated with five men—a shovel operator, oiler, a batcher man, and two laborers cleaning car bottoms.

Proportional material was hauled from the plant to the road by Coleman trucks, partitioned for three 7-bag batches. From six to twelve of these trucks were used, depending upon the length of haul. "Subgrade on these projects was extremely sandy and it was felt that the performance of these trucks was a big factor in the successful completion of the work," said Mr. Collins.

Equipment on the road consisted of a 27-E Multifoote paver with subgrade attachment, an Ord finishing machine, a 5-ton turntable, two teams and a utility truck. The labor here consisted of a mixer operator, truck dumper, four subgrade finishers, two center joint men, three concrete placers, one finishing machine operator, three hand finishers, three form setters, eight curing men, one sack salvager, two form haulers, one teamster, two form movers and one utility truck driver; a total of 33 men.

Owing to the excellent coordination which the contractor was able to inject into this organization, the whole operation seemed to work with

clock-like precision—no one in a hurry, no one overworked, and still recording a high daily output.

A water-cement ratio of .70 was carefully maintained throughout, and excellent aggregates used, which resulted in uniformly high-test concrete. Seventy-two test cylinders from one of the contracts developed an average 28-day breaking test of 5,116 pounds per square inch; and 111 test cylinders from the other contract (the one first constructed) developed a 28-day average of 4,644 pounds per square inch.

Sludge Disposal in Germany

Sludge disposal by separate digestion, with utilization of gas, in eight German cities, as reported by a committee from an English city which visited the plants last year

Last year a deputation from the Manchester (England) Corporation Rivers Committee visited a number of German sewage treatment plants in order to obtain first-hand information concerning sludge disposal by separate digestion, with or without recovery of the gaseous products, with a view to aiding the committee in deciding upon improved methods for disposing of Manchester sewage.

This committee has recently published its report. The report begins with a description of the Emschergenossenschaft, a board entrusted with the regulation of the Emscher river and sewage purification in the Emscher district; and also of the Ruhrverband, a board which performs similar service for the Ruhr basin. In the Emscher basin there is a total population of about 2,300,000 and about 26 sewage treatment plants and three for stream purification; and in the Ruhr basin a population of about 1,250,000, which are served by about 25 sewage purification plants, with many more projected.

The report describes the sewage treatment plants at 15 different cities, at 8 of which the gas is collected and utilized. The following paragraphs are condensed from the report of this commitee, describing first those plants in which gas utilization is practiced.

At Essen Frohnhausen there is a population of 50,000 and a dry-weather flow of two million gallons a day. The plant consists essentially of two long sedimentation tanks situated close to the foot of a central sludge chamber, which is built partly above ground. The sludge from the sedimentation tanks is discharged daily in to the digestion chamber by means of a portable pump operated by compressed air which travels from end to end of the two sedimentation tanks. Two screw sludge-circulation devices are installed in the digestion chamber, which has a capacity of 31,770 cubic feet, which give a thorough incorporation with its contents of the 880 cubic feet of fresh sludge added daily. All of the gas evolved is collected under a single hood. No difficulty has been experienced with scum in collecting the gas, because the accumulation of floating matter is prevented by the circulating devices.

Essen Nord has a population of 200,000 and a dry-weather flow of approximately 20 million gallons per day. It receives the bulk of the waste liquors from Krupp's iron and steel works and also from many mines and other industrial works. There are 18 Imhoff tanks, 12 designed for horizontal flow and 6 for upward flow, all provided with gas collectors. A separate sludge digestion chamber has recently been installed as an auxiliary to the digestion chambers of the Imhoff tanks. About 71,000 cubic feet of gas is evolved per day, or one third of a cubic foot per capita, and is conveyed to the public gas supply under a pressure of 8 inches of water.

Rellinghausen has a population of 45,000 and a dry-weather flow of about 6 million gallons per day, a large part of which is infiltration of ground water. Imhoff tanks were built in 1912, and in 1925 a new type of activated sludge plant designed by Dr. Imhoff in which spiral motion is effected by means of revolving submerged longitudinal wooden paddles running the entire length of the aeration chambers. It is stated that adequate purification is obtained with a detention period of 3½ hours and an air consumption of not more than one tenth cubic foot per gallon of sewage treated (it is to be remembered that the sewage treated is of a weak character); while the total power required for operating the paddles and air compressing is given as 8 h.p. per million gallons. The surplus sludge from the activated sludge plant is pumped to the preliminary Imhoff tank and digested there together with the sludge derived from sedimentation in the tank. As the total digestion chamber capacity is not sufficient for all of the sewage, a supplementary digestion tank has been installed. Arrangement is made for increasing the temperature of this plant in the winter time by introducing water heated to about 80 degrees centigrade by means of gas evolved during digestion. The remainder of the gas produced is sold to the municipal gas works.

Bochum, with a population of 180,000, has a dry-weather flow of about 10 million gallons per day. In 1926 Imhoff tanks were built to deal with the sewage from 80,000 people, and the old tanks, built in 1907, are being reconstructed for dealing with the remainder of the sewage. Provision is made for collecting all the gas from the digestion chambers and conveying it to the town's mains.

Berlin with a population of 4,150,000 has an average sewage flow of about 133 million gallons per day, which is pumped to sewage farm lands from 9 to 15 miles from the center of the city. As it is difficult to treat all of this unclarified sewage on the area available, more or less pre-

liminary treatment is being given to the sewage, more new preliminary treatment plants being added from time to time. The most recent development is the construction at Wassmannsdorf of a complete Imhoff tank installation with provision for collecting gas from the digestion chambers. Here the sewage from a population of 560,000 is dealt with, the dry-weather flow amounting to from 17 million to 18 million gallons per day. The digestion chambers of the Imhoff tanks have a total capacity of 31,000 cubic yards and a depth of 28 feet below the slot. The total gas production amounts to 212,000 cubic feet per day or about 0.4 cubic foot per capita. The effluent is turned on to the adjacent land, and the digested sludge, which has a water content of approximately 80%, is discharged onto specially prepared drying beds. The gas collected is passed through chambers containing saw dust and bog-iron ore to remove water and traces of sulphurated hydrogen, and then passes to a gas holder of 106,000 cubic feet capacity. Part of the gas is used to operate two gas engines of a total of 360 British h.p. and for heating and lighting various buildings, including dwelling houses connected to this sewage disposal station, but a considerable volume is burned to waste. The deputation was informed that proposals were in hand for installing activated sludge plants at Wassmannsdorf and Stahnsdorf to deal with 22 million gallons of sewage per day, these plants to be operated by the diffused air method; and it is hoped that sufficient power to operate the necessary compressors will be obtained from the gas resulting from decomposition of the sludge.

Munich, with a population of 460,000 connected to the sewerage system, has a dry-weather flow of 50 million gallons per day, of which 40 percent is ground water and brewery waste. The sewage passes through detritus chambers with fixed bar screens and then through 16 Imhoff tanks. An unusual feature of the design of these tanks is a provision whereby a small flow of fresh sewage is constantly forced through the digestion chambers, whereby it is claimed that there is a considerable increase in the gas yield and at the same time its value is enhanced by a reduction in the percentage of carbon dioxide. Gas is being collected from one of the Imhoff tanks for demonstration and investigation purposes but it is proposed eventually to collect the whole of the gas from the digestion chambers and turn it into the town's mains. At present the tank effluent passes directly to the river, but construction is well advanced on a series of shallow fish and duck ponds for the final biological purification of the sewage. These ponds which extend for a distance of more than four miles are approximately 1,200 feet wide. Tank effluent and river water in a proportion of 1 to 5 will pass slowly through these ponds and overflow to the river. Tank effluent will be admitted to the ponds in the form of a thin fan-shaped film or spray, which will effect a certain amount of aeration. It is estimated that more than 100 tons of carp and other fish will be raised here and about 60 tons of ducks in the course of the year. The value of this produce will be sufficient, it is hoped, to cover the capital cost and maintenance expenditure on the new work.

Stuttgart, with a population of 350,000 and a dry-weather flow of about 15 million gallons per day, is utilizing tanks of three types—Imhoff tanks, Stuttgart tanks, and New City tanks, in each of which provision is made for sludge digestion and gas collection. The Imhoff tanks are of the usual type. The Stuttgart tank has settlement channels running parallel on either side of the digestion chambers, and the sludge passes from the settlement tanks through a slotted floor to the digestion chambers. In the New City tanks, the settlement channels are grouped longitudinally between the digestion chambers. The addition of sludge to the digestion chambers is controlled in this case by penstocks. No decided preference was exhibited between these three types of tanks, but it is understood that the construction costs per unit capacity are highest for the Imhoff tanks and lowest for the Stuttgart tanks. Gas is conveyed to the town's mains, about 6 miles distant, under 0.5 atmospheric pressure, power for creating this pressure being obtained by utilizing the fall of sewage effluent from the tanks to the river outlets. The total gas produced is 35,000,000 cubic feet per year, for which there is obtained about 50c per thousand cu. ft. This amounts to about one-third of a cubic foot per capita per day, but it is proposed to increase the amount by heating the sludge in the digestion chambers during winter.

Cologne, population 750,000, has a dry-weather flow of about 38 million gallons per day, which at present is discharged into the Rhine with only the coarse suspended matter removed by bar screens. Plans are under consideration for screening the sewage through fine belt screens, from which the screenings will be washed by spraying water upon them and the combined water and screenings will then be digested in separate digestion tanks. The gas will be collected and utilized to heat the digestion chambers and operate the mechanical plant.

In general, the policy of the Emschergenossenschaft has been to limit the treatment of sewage to the removal of settleable solids which would interfere with the free flow of the stream, and to utilize the Emscher and its tributaries as open channels for carrying the partially treated sewage and industrial waste to the Rhine. Stream purification plants have been and are being built for treating the whole Emscher flow, with the object of reducing the suspended matter, which consists mainly of coal dust derived from coal washing plants.

One of the river purification plants is under construction at Karnact, which will be the largest station for the treatment of the river flow. It consists of four sedimentation tanks, each 500 feet long by 164 feet wide by 13 feet deep, so constructed that sludge must be removed without emptying the tank, which is done by means of a portable pump attached to a travel-

ling pontoon stage. The sludge, containing 70 to 80% water, is to be pumped direct onto 40 acres of drying beds, where the water content will be reduced to about 50%. It is proposed to treat an average daily flow of 187 million gallons, at which rate the horizontal velocity through the basins will be 5 feet per minute and the detention period about one hour. This plant will cost about $750,000 and the operating costs apart from capital charges are estimated at about $50,000 a year.

In the Ruhr Valley, however, more purification is necessary, as there are 90 different water works supplying about 250 million gallons per day for domestic and trade purposes, most of the water for which is taken from wells and infiltration galleries about 150 feet from the river. The Ruhr basin has been divided into three zones, the first including three towns with a combined population of 242,000, the sewage from which is carried by an intercepting sewer to the Rhine, where it is treated in Imhoff tanks. Zone B is the water works line, in which district complete sewage purification plants yielding a high-quality effluent are required; with chlorination where necessary. Zone C, while covering by far the largest area, is mainly sparsely populated woodland, and the degree of sewage treatment in this district is governed by consideration of local conditions.

Summing up the result of their investigations, the committee says:

"It will be seen from the foregoing report that secondary digestion with recovery and utilization of the gaseous products of fermentation is being almost invariably adopted in Germany as the best and most economic means of sludge disposal.

The importance of temperature in accelerating the digestion process has been emphasized everywhere and there can be no doubt that heating of the sludge in the digestion chambers is essential to the economic application of the process when separate-digestion tanks are used. With this aid, not only is the gas production per capita considerably increased, but the detention period required for complete digestion of the sludge is very materially diminished, with consequent reduction in the capacity of the digestion tanks.

It is claimed that with the maintenance of a temperature approaching 25 deg. C. and the regular and thorough incorporation of the additional fresh sludge and ripe sludge, the cubic capacity of the digestion tanks need not exceed 1 cub. ft. per capita, and that the gas production will amount to from 0.5 to 0.7 cub. ft. per capita per day. If activated sludge is digested the gas production will be appreciably higher than these figures.

Although liable to some variation in composition, in general the gas evolved consists of methane, CH_4 (70 to 75 per cent), and carbonic acid, CO_2 (25 to 30 per cent), with trifling amounts of nitrogen and hydrogen. It is stated that the gas evolved from the Munich sludge contains as much as from 75 to 84 per cent methane. How far this somewhat abnormal composition is due to the method of operating their two-story tanks, and how far it may be possibly affected by the large amount of brewery waste in the sewage treated, is not known.

The thermal value of the gas (650 B.T.U.) is very considerably higher than that of ordinary town's gas (450 B.T.U.). The price obtained for the gas from the various sewage works in Germany varies from 1s. per 1,000 cub. ft. (3.5 pf. per cub. metre) in the Essen and Ruhr districts, which price is controlled by that paid by the gas authority to the coke oven factories, to 2s. per 1,000 cub. ft. (7.0 pf. per cub. metre) in Stuttgart. Naturally, a better financial return from the gas is obtained if it is utilized in the form of power, lighting, etc., at the sewage works.

It is important to note that in no instance was any aerial nuisance observed which might be attributable to the digested sludge discharged from the digestion tanks.

Your representatives are so satisfied from the works they have seen in actual operation, and from the data which they have received, of the practical character of this method of sludge disposal, that it seems to them probable it could be advantageously applied in connection with the treatment of the Manchester sewage.

Defects at English Sewage Works

Sewage by-passed to river in many cases where not suspected. Septic action in tanks considered objectionable

Many writers, both American and foreign, have stated that the inferiority complex was one of the outstanding features of American character, although it is generally believed that as a nation we are gradually outgrowing this. However, many Americans still believe that in most matters, including sewage treatment, they do things better on the other side. Reports come both from English sources and from the reports of Americans who have visited English plants, of the success which is found almost invariably in the sewage treatment works in England.

It may therefore come as a surprise to many American engineers to learn from a frank statement by H. C. H. Shenton, one of the leading sanitary engineers of England, that not all English sewage treatment plants are as perfect as they appear to the visiting engineers. In an article entitled "Common Defects at English Sewage Disposal Works," he states that experienced engineers who have visited sewage disposal works throughout his country must have noticed that there is an obvious "back door" through which crude sewage must at times flow untreated into the river, and that such "back doors" are more common than is usually supposed. "An overworked system frequently possesses complicated arrangements of pipes, valves and channels through which, under certain conditions, crude sewage or crude tank effluent may be discharged into the river in large quantities; and in many cases it is perfectly obvious to the intelligent observer that it would be impossible to run the works without such a discharge being made, possibly on dark nights or in times of fog, flood or storm. So well is this fact known, that judges in the courts appear to attach little value to expert evidence showing the purity of effluents or the excellence of the design and construction of the works. If evidence is given to the effect that a river is polluted, very little attention will be paid to the fact that the filters are producing a proper effluent, because the judge knows that rivers are very often polluted by unauthorized outlets and overflows which exist at places where the actual purification works are to all appearances well designed and where they actually do produce a first class effluent. The suspicion that these may exist is always present and reduces expert evidence to a farce.

"There are other obvious facts which must

strike the inspecting engineer. Ordinary storm-water overflows which come into action when the rate of flow exceeds six volumes (of dry weather flow), frequently discharge crude sewage. A slight blockade in the sewer beyond the overflow will produce this result, and as the overflow sill has often been fixed originally for a certain calculated volume which has been largely exceeded in the course of time, the result is frequently most unsatisfactory. Such overflows often produce a foul discharge if sudden large flushes come down the sewer; and even in time of storm, owing to the washing of sewers, the cleanliness of storm water is more theoretical than practical, and its quality is frequently worse than that of the ordinary crude sewage."

As most of our readers probably know, most of the sewers in England are on the combined system and probably a great majority of them are provided at intervals with overflows into the nearest stream or other body of water, which overflows permit to reach such streams all of the surplus over and above from three to six times the ordinary dry-weather flow.

In illustrating this, Mr. Shenton cited a case in which suit was brought because of odor given off by a sewage treatment plant. The experts stated that no nuisance could occur from the disposal works; but while they "were perfectly sincere and correct in their statement, the local authority had failed to explain to them that they possessed what amounted to a secret pumping main which delivered storm water, or so called, onto an area of land situated in an inconspicuous position. As a matter of fact, the disposal works, which were totally inadequate to deal with the flow of sewage actually produced in the town, only purified a certain proportion, and all the rest of the flow, which was nominally storm water, was pumped onto the land." A judgment was quite properly given against this plant.

Mr. Shenton says that for such conditions "there is only one possible remedy, and that is to make sewage disposal works of such capacity that they can deal with the greatest possible flow. Where ordinary calculations show that the reverse is the case, one may look confidently for the back door, which, although it may not be obvious at the first glance, must certainly exist."

The author then refers to the matter of leaking sewers, which he takes for granted exist in most cases, stating that while these frequently admit ground water and thus increase the amount of sewage to be treated beyond that calculated, thus being partly responsible for the overloading referred to, on the other hand they may allow the escape of water. "Careful investigations will sometimes show that the quantity of sewage entering a given section of a sewerage system must of necessity be larger than the capacity of the main sewer, and that when the maximum flow occurs, sewage must be head up in the manholes and escape freely into the ground when unsound sewers exist. There are certainly cases in which the substratum on which the town is built is serving the purpose of a sub-irrigation sewage disposal area."

There are cases in this country where cities owning sewage treatment plants openly discharge untreated sewage into streams under certain conditions, such as a volume of flow in the stream temporarily exceeding that necessary for proper dilution of the sewage; and it is possible that there are cases in which surreptitious pollution of the stream occurs, such as that referred to by Mr. Shenton, but we doubt that the practice is as common in the United States as it apparently is in England. We believe that most of the state health departments now refuse to accept plans for sewage treatment works which provide means by which discharge of crude sewage into the river could be resorted to under any condition. Storm water overflow from combined sewers into streams used to be occasionally practiced in this country; but the building of combined sewers has nearly gone out of practice in the United States except for occasional extensions of systems already built on the combined principle.

At the end of his paper Mr. Shenton brings up a point which is equally applicable to American practice, and that is the impracticability of obtaining good sedimentation in a septic tank, or the inadvisability of allowing septic action to take place in sedimentation tanks. "The settling tanks have to do the work which properly should be done in a sludge digesting tank. The two things can not be satisfactorily combined. The remedy is surely obvious and simple, namely, to intercept the fresh sludge at an early stage and give it separate treatment. The value of intercepting as much of the organic matter as may be possible in a preliminary tank has been grasped by the advocates of various activated sludge processes, but it is not so clear that even these persons have fully grasped the importance of refraining from passing the full flow of sewage through a tank in which the solids have not only been intercepted, but in which septic action takes place involving disintegration of the solids. Clearly the sludge should be removed daily and placed in the digestion tank, a matter which is by no means difficult to arrange."

In the practice thus recommended by Mr. Shenton, United States plants seem to be ahead of the English, as evidenced by the increasing use of separate digestion tanks and of mechanical appliances for continuously removing sludge from sedimentation tanks so as to prevent even the inception of putrefaction in such tanks.

Sewage Treatment Voted for East Rochester

The taxpayers of the village of East Rochester, N. Y., voted recently to expend $190,000 for the construction of sewage treatment works. These works, consisting of a bar screen, Dorr detritor and drum screen, sedimentation tank with separate sludge digestion tank, sprinkling filter, final settling tank and sludge drying beds. will be constructed this year. Plans for the work have been examined by the Division of Sanitation and approved by the State Commissioner of Health of New York.

Recent Legal Decisions

MISTAKE IN BID—CONTRACTOR'S CLAIM FOR VALUE OF WORK DONE AND ACCEPTED

The New York Court of Appeals holds, Shaddock v. Schwartz, 246 N. Y. 288, 158 N. E. 872, that where there was advertisement of a public works contract and public bidding, and a slip was made by the successful bidder in the form of his bid, making a variance between the bid and the plans and specifications, but the city would have been the loser if the bid had been rejected, "the adjudged cases supply ample basis for the conclusion that, upon acceptance of the work performed under these conditions, there arose a moral obligation to pay its reasonable value, which might be converted into a legal obligation in the discretion of the council." And under New York General City Law, section 20, subd. 5, authorizing cities to pay or compromise equitable claims, it is held that there is no basis for holding that compensation is to be limited to the contractor's outlay, including the customary profit; but rather that the compensation is to be measured by the fair and reasonable value of his material and labor, which includes such profit as would be due him in an action on quantum meruit.

PRIOR OWNER'S UNPAID WATER RATES—EFFECT OF CONTRACT BETWEEN MUNICIPALITIES

The Ohio Supreme Court holds, Western Reserve Steel Co. v. Village of Cuyahoga Heights, 161 N. E. 920, that a village which has a contract with a city for a water supply to the inhabitants of the village, cannot refuse to permit the city to supply water to a consumer whose property is situated upon an existing main, installed and owned by the village, for the sole reason that the present owners of the premises are unwilling to pay an indebtedness incurred by a former owner, which indebtedness is not a charge upon the premises, and of the existence of which the present owners had neither notice nor knowledge. As to the city's duty in the matter the court's syllabus 4 reads: "Where a municipality contracts to supply water to the public of another municipality, it dedicates itself in that respect to the service of the public of such other municipality; and while it may limit, by contract, the scope and extent of its duty to the municipality as such, it cannot, while enjoying the privileges and immunities of a public utility, by such contract absolve itself from the duties toward such public that are cast upon it by law by reason of such dedication."

"CONTRACTOR" DEFINED

While, in a strict sense, both parties to a contract are contractors, yet in a general sense, as a commonly recognized reserved designation, a contractor is one who enters into a contract to do a special piece of work for another, according to price, specifications and terms agreed upon. Chase v. Clinton County, 241 Mich. 478.

PROCEDURE ON BREACH OF DITCH CONSTRUCTION CONTRACT

In an action for breach of a ditch construction contract it appeared that the contractors encountered rock and, instead of excavating to the required depth, they excavated only to the rock, and laid the tile on the surface of the rock. This was done by agreement with the engineer, but without the consent of the county board. The Minnesota Supreme Court holds, County of Hennepin v. Richardson, 220 N. W. 432, that this was deviation from the contract which constituted a breach thereof, for the engineer could not relieve the contractors of their obligation to lay the tile at the specified depth. The Minnesota statute, Gen. St. 1923, §6691, requires the county, where neither the contractor nor his bondsmen complete the ditch, to cause it to be completed, unless the cost will exceed the limit fixed by statute. In determining this, payment to the contractors for work done contrary to the contract and of no benefit to the project are to be excluded.

ACCEPTANCE OF PUBLIC BUILDING BY BOARD

While an acceptance of a building by a school board does not require the formal acceptance by motion or resolution passed by the board in session, the Minnesota Supreme Court holds, Guaranteed Gravel & Sand Co. v. Aetna C. & S. Co., 219 N. W. 546, that it does require an act with intent to receive the building as its own as a compliance with the required duty of the contractor.

REASONABLENESS OF EXCLUSION OF LAND FROM TOWN LIMITS

In determining the reasonableness of the exclusion of land from town limits, the Mississippi Supreme Court holds, Wheat v. Town of Poplarville, 115 So. 559, that the isolated power of taxation cannot be considered as either a benefit to the municipality or a detriment to a taxpayer properly included within the district. The use of the streets of the town is not persuasive, for the streets, as the public highways of the country, are used for public travel, and not for the exclusive benefit of those living within the area having improved streets and other conveniences of a progressive municipality.

MISSISSIPPI STATUTE REQUIRES PUBLIC INTEREST OR CONVENIENCE TO BE SHOWN BEFORE CONDEMNING LAND FOR HIGHWAY

Under the Mississippi statute, Hemingway's Code 1927, §8340, public roads may be laid out and lands condemned therefor only when it is shown to the board of supervisors that the public interest or convenience requires them. Where the board did not adjudicate on its minutes that the laying out and establishment of a public road

was required by public interest or convenience, as required by the statue, the Mississippi Supreme Court holds, Ferguson v. Board of Supervisors of Wilkinson County, 115 So. 779, that an order condemning a right of way for a public highway was void, since the matter was jurisdictional.

METHODS OF ACQUISITION BY MUNICIPALITY OF PLATTED LANDS INCLUDED IN EXTENSION OF LIMITS

The Mississippi Supreme Court holds, Givin v. City of Greenwood, 115 So. 890, that it is permissible for an owner of land in a rural section to cut it up into lots, with streets, avenues and alleys, and reserve to himself the right to operate utilities for furnishing water, lights, sewerage and similar things. In general, the dedicator may prescribe restrictions and limitations on the use of the land so dealt with. If, after the owner has mapped, plotted and sold lots in such land, a municipality extends its limits so as to take in the platted rural section, it will, it is held, acquire such streets, avenues and alleys burdened with the reservations contained in the maps, deeds, etc.; but it may proceed to condemn and acquire them by paying just compensation therefor under section 17 of the Mississippi Constitution of 1890.

ASSESSMENT OF LOT ABUTTING STRIP DEDICATED FOR PARK PURPOSES

An owner dedicated land to a city for park purposes. A strip designated on the plat for "Park Purposes" abutted on an avenue. The owner of a lot adjoining this strip and abutting on another avenue was assessed for paving the first mentioned avenue. The Michigan Supreme Court, Jend v. City of Detroit, 219 N. W. 620, held the lot was not subject to the tax. The city had not assumed to use the strip as part of the street; its pavement did not cover any portion of it; he lot owner had not a corner lot, and could make no use of the strip inconsistent with its use by the public for park purposes. When land is dedicated for park purposes by the owner and accepted by the city, its use as such cannot be restricted by any action of the municipality.

COMPLIANCE WITH PROVISION FOR WRITTEN ORDER FOR EXTRAS

The Louisiana Supreme Court holds, Delaney v. John O. Chisholm & Co., 166 La. 406, that where a subcontractor on a school building fails to comply with a provision of the specifications that no allowance will be made for extra work unless ordered in writing by the City engineer and a bill in duplicate therefor submitted to and approved by him, compensation for extra work done by him will not be allowed in an action against the principal contractor.

EXTENSION OF MUNICIPALITY'S LIMITS TO INCLUDE LAND OF ANOTHER TOWN

The Mississippi Supreme Court holds, City of Pascagoula v. Krebs, 118 So. 286, that an ordinance whereby a municipality undertook to extend its limits to include therein a considerable portion of the territory of another existing town, functioning as such, and continuing to function for many years thereafter, without any consent or any action on the part of such town, is void, since one municipality cannot so extend its boundaries as to include another municipality without its consent. Such an ordinance is held to be subject to collateral attack by proceedings to enjoin the collection of taxes.

RECOVERY ON CONTRACT PROVIDING FOR MEASUREMENT BY YARDAGE

The Mississippi Supreme Court holds, Stowell v. Clark, 118 So. 370, that where a subcontractor completed work on a highway pursuant to a contract providing for measurement by yardage by the engineer in charge of the work, he was entitled to recover under Hemingway's Code, 1927, §§ 2617-2622, on showing the amount of work done by a force account on the engineer's failure to measure the yardage, in view of the fact that the yardage and force account were interconvertible terms and one could be ascertained from the other by calculation. He was held entitled to recover an agreed on bonus as well as the contract price, that being as much a part of the contract price as the yardage price.

DEFECTIVE MOTION TO RETAIN SERVICES OF SUPERVISORY ENGINEERS

The Louisiana Supreme Court holds, Mentz v. Village of Mamon, 165 La. 1070, that a motion passed by an outgoing board of aldermen for the purpose of retaining the services of engineers to supervise the construction of a proposed system of waterworks, which made no provision for compensation of the engineers or the time or manner in which it should be paid, or for the execution of a bond by them, was fatally defective as an original agreement of employment. Its only effect would be to entitle the engineers in a proper proceeding to recover on quantum meruit for such services, if any, they rendered the village between the date of the passage of the motion and the date the successors of the board which adopted it rescinded or ignored it.

EXECUTED CONTRACT FOR SALE OF ROAD BONDS AT LESS THAN PAR

A contract for the sale and purchase of district road bonds was made and fully and completely performed, the effect of which was to sell the bonds for less than par, in violation of the Louisiana constitutional provision forbidding such sale. The Circuit Court of Appeals, Fifth Circuit, Police Jury v. Caldwell & Co., 26 Fed. (2d) 74, holds that the parish which sold the bonds was estopped from suing to recover unearned interest by reason of noninterest-bearing time certificates of deposit having been issued to the parish, since the parish had received the benefits of the contract and did not offer to return the proceeds of the bonds which it had received.

ROAD REACHING ONLY ONE PROPERTY OWNER MAY BE A "HIGHWAY"

A road may be a highway though it reaches but one property owner. He has a right of access to other roads and the public has a right of access to him. Its character is not determined by the fact that few persons use it. Nicholas v. Grassle, Colorado Supreme Court, 267 Pac. 196.

NEWS OF THE SOCIETIES

April 15-16—SOUTHERN WATER & LIGHT ASSOCIATION. Annual Convention at Birmingham, Ala.

May 13-15—NATIONAL HIGHWAY TRAFFIC ASSOCIATION. Annual Convention. Stevens Hotel, Chicago. Secretary, Elmer Thompson.

May 20-23—NATIONAL CONFERENCE ON CITY PLANNING. Annual Conference at Buffalo, N. Y. Flavel Shurtleff, Secretary, 130 E. 22nd St., N. Y.

June 24-28—AMERICAN WATER WORKS ASS'N. Annual Convention at Toronto, Ont. Beekman C. Little, Secretary, 29 W. 39th St., N. Y.

Sept. 17-20—NEW ENGLAND WATER WORKS ASSOCIATION. Annual Convention at Portland, Me. F. J. Gifford, Secretary, 715 Tremont Temple, Boston, Mass.

Sept. 30-Oct. 4—AMERICAN PUBLIC HEALTH ASSOCIATION. Annual Convention at Minneapolis, Minn. Homer M. Calver, Secretary, 370 Seventh Ave., N. Y.

Oct. 14-16—INTERNATIONAL ASSOCIATION OF STREET SANITATION OFFICIALS. Annual Convention at Jacksonville, Fla. A. M. Anderson, Secretary, 100 North LaSalle St., Chicago, Ill.

Oct. 14-18—AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS. Annual Convention at Philadelphia, Pa. C. V. S. Sammelman, Secretary, St. Louis, Mo.

HIGHWAY RESEARCH BOARD

The Executive Committee of the Highway Research Board, National Research Council, has announced the formation of a special committee to conduct an investigation of the problem of proper curing methods for concrete pavements. The work will consist largely in correlation of the research work being carried on by the Bureau of Public Roads and various state highway departments.

The committee consists of: Chairman, F. C. Lang, University of Minnesota and Minnesota State Highway Department; E. F. Kelley, Chief of the Division of Tests, U. S. Bureau of Public Roads, Washington, D. C.; W. A. Slater, Research Professor of Engineering Materials and Director, Fritz Engineering Laboratory, Lehigh University, Bethlehem, Pa.; F. V. Reagel, Engineer of Materials and Tests, Missouri State Highway Department, Jefferson City, Missouri; Frederick E. Schnepfe, Civil Engineer, Washington, D. C.; H. F. Gonnerman, Manager Research Laboratory, Portland Cement Association, Chicago, Illinois; Stanton Walker, Director of Engineering and Research Division, National Sand & Gravel Association, Washington, D. C.

The work of the investigation will be carried on by Fred Burggraf under the general direction of R. W. Crum, Director of the Board.

THE ASPHALT ASSOCIATION

LeRoy M. Law of New Orleans, has been elected president of The Asphalt Association, succeeding J. S. Helm of New York, president for the past two years. Mr. Law is a leading official of the New Orleans Refining Company, one of the Shell group of oil companies, and served last year as president of the National Association of Asphalt Paving Technologists.

Other officers elected by the association for 1929 are: W. H. Kershaw, manager, Asphalt Sales Department, The Texas Company, New York, and C. W. Bayliss, vice-president, Barber Asphalt Company, Philadelphia, vice-presidents; Fisher Jones, manager, Asphalt Division, Mexican Petroleum Corporation, New York, treasurer, and J. E. Pennybacker, New York, secretary and general manager. J. S. Helm, general manager, Domestic and Foreign Asphalt Sales Department, Standard Oil Company of New Jersey, the retiring president, heads the new executive committee which, besides Messrs. Law, Kershaw and Jones, includes J. A. Feely, manager, Asphalt Department, Atlantic Refining Company, Philadelphia.

The board of directors for 1929 includes, in addition to Messrs. Law, Bayliss, Kershaw, Helm, Jones and Feely, the following: C. C. Lakin, manager, Asphalt and Road Oil Department, Standard Oil Company of Indiana; F. A. Hogan, manager, Asphalt and Road Oil Department, Imperial Oil Company, Ltd., Canada; H. C. Ehrenfelds, manager, Asphalt Sales Department, Standard Oil Company of Louisiana; E. J. Morrison, president, Hastings Pavement Company, and B. L. Boye, Road Oil Department, Standard Oil Company of New York.

For the first time since the Asphalt Association was organized in 1919, its membership is almost completely representative of the asphalt producers east of the Rocky Mountains. This was brought about by the election, as new members, of The Texas Company, the Barber Asphalt Company and the Atlantic Refining Company. Indications are that, with one or two exceptions, every asphalt producer east of the Rocky Mountains shortly will be in the organization. California producers are also considering membership.

With this step toward unity accomplished, the association is setting out to broaden its policies with a view to having the industry become a constructive factor in working out not only the problems incident to the industry but those which have a tangible bearing upon the progress and prosperity of the nation as a whole. The first step has been to enter into official cooperation with the U. S. Bureau of Public Roads in a research program, looking to the improvement at low cost of the vast mileage of secondary or farm-service roads. A committee representative of the industry, and consisting of Messrs. Pennybacker, Kershaw, Helm, Bayliss, Feely, Lakin and Law, has been constituted to cooperate with Thomas H. MacDonald, chief of the U. S. Bureau of Public Roads, on this important problem.

A technical committee to work out the problems of research, standardization and simplification of grades in cooperation with the various governmental and scientific bodies was created, with Prevost Hubbard, chemical engineer of the Asphalt Association, as chairman, and a technologist from each of the asphalt refineries as members.

Decision as to the time and place for the Eighth Annual Asphalt Paving Con-

Pages 61 to 68 for latest developments in Equipment Materials and Methods

ference, to be held next fall, was laid over to a later meeting, as representatives of many cities which have extended invitations have asked for the opportunity to present their invitations in person. The places which are most active in seeking the annual convention include Montreal, Canada; West Baden Springs, Ind.; Palm Beach and Miami, Fla.; Detroit, Mich.; Cincinnati and Cleveland, O.; Atlantic City, N. J.; Philadelphia, Pa.; St. Louis and Kansas City, Mo.; Buffalo, N. Y., and Richmond, Va.

AMERICAN WATER WORKS ASS'N.
Rocky Mountain Section

The Rocky Mountain Section of the American Water Works Association held its third annual meeting in Denver, February 14 and 15, 1929. The technical papers presented were as follows: Distribution Systems and Service Pipes, P. R. Revis, City Engineer, Cheyenne, Wyoming; A Small Filtration Plant, Chester Truman, Supt., Northfield Water Co., Colorado Springs, Colorado; La Junta's Sewage Pumping Plant, Geo. E. Hine, City Engineer, La Junta, Colorado; Taking the Hardness Out of Water, R. E. McDonnell, Consulting Engineer, Kansas City, Missouri; Engineering Problems in Connection with Water Rights, Geo. M. Bull, Consulting Engineer, Board of Water Commissioners, Denver, Colorado; Legal Problems in Connection with Water Rights, Malcolm Lindsay, Attorney, Board of Water Commissioners, Denver Colorado; Wells as a Source of Municipal Water Supply, Wynkoop Kiersted, Jr., Consulting Engineer, Kansas City, Missouri; Round Table Discussions were held on Mechanical vs. Slow Sand Filters, Prechlorination, and miscellaneous water works subjects. Talks illustrated with lantern slides and motion pictures included: The St. Francis Dam Failure, by R. E. McDonnell; Water Purification and Sewage Treatment Equipment, by E. M. Kelly, representing the Dorr Co.; Pipe Line Construction at Colorado Springs, by J. J. Wilson, representing the National Tube Co.; Trenching Machines, by T. R. Elkins, representing the Wilson Machinery Co.

Demonstrations of coagulation, filtration and zeolite softening were given by E. W. Lasley, Vice President, The Flox Co., and Dana E. Kepner, Colorado State Sanitary Engineer, both of Denver, Colorado.

Inspection trips included the shops and equipment yard of the Denver Municipal Water Works, where demonstrations of tapping and other pipe work were given; and the plant of the Gardner-Denver Co., where the manufacture and operation of compressed air tools were shown.

The election of officers resulted as follows: Chairman, P. R. Revis, Cheyenne, Wyoming; Vice Chairman, D. D. Gross, Denver, Colorado; Secretary-Treasurer, Dana E. Kepner, Denver, Colorado. Directors (elected), E. C. Gwillim, Sheridan, Wyoming, and Wm. W. Nielson, Santa Fe, New Mexico. Directors (held over), D. V. Bell, Rock Springs, Wyoming; Paul S. Fox, Santa Fe, New Mexico; E. A. Lawver, Ft.

Collins, Colorado; A. W. Stedman, Canon City, Colorado.

Exhibits of water works equipment were omitted, at the request of the Manufacturers Association.

AERONAUTIC DIVISION OF AMERICAN SOCIETY OF MECHANICAL ENGINEERS

An aeronautic meeting for engineers is being planned for May 27 to 30 by the St. Louis Section of the American Society of Mechanical Engineers in cooperation with its Aeronautic Division. A general committee has been appointed with Major A. B. Lambert as honorary chairman and Victor J. Azbe as general chairman; other members on the committee are Frederick E. Bausch, vice-chairman, P. DeC. Ball, Col. J. A. Paegelow and Major C. R. Wassal.

The meeting will consist of sessions of general interest to all engineers and aviationists. There will be one on Air Transport which will have for speakers a representative of the railroads, Casey S. Jones, famous pilot of the Curtiss Airplane & Motor Corporation; C. S. Moseley, of the Western Air Express, and Lieut. C. N. Montieth of the Boeing Aeroplane Co. Prominent experts in the aviation field will attend the meeting and will discuss the technical problems confronting the industry.

Conferences will be held during the meeting for the aeronautic experts on such subjects as structural analysis of aircraft, the status of light Diesel engines for airplanes, maintenance and location of airports, fog flying and ice formation on airplanes, installation and servicing of aircraft instruments, etc. During the meeting the Gardner Cup Air Races will be held at the Parks Airport, May 28 to 30.

AIRPORT CONVENTION

The first Airport Convention will be held in Cleveland, Ohio, May 16, 17, 18, according to an anouncement by Capt. Clarence M. Knox, vice-president in charge of the Airport section of the Aeronautical Chamber of Commerce.

A tentative program includes discussions and addresses on various phases of airport lighting, landing field construction and care, inter-field communication and meteorology, design and architecture, safety control, maintenance and administration, and standards of practice.

The following have been appointed on the Convention Committee: Local Convention Program—Major John Berry, manager, Cleveland Municipal Airport; entertainment—B. E. Fulton, manager, Fulton Field, Akron, Ohio; registration—Gabriel C. Harmon, manager, Trans-Continental Airport of Toledo; membership—Clifford Henderson, director of airports, City of Los Angeles; demonstration—E. A. Johnson, operator, Dayton Airport; program—Harry Schwarzschild, publisher, Airports, and R. W. Whitney, manager, airport section, Aeronautical Chamber of Commerce.

Information regarding the convention may be secured from R. W. Whitney, Aeronautical Chamber of Commerce, 300 Madison Ave., New York.

AMERICAN MOTORISTS ASSOCIATION

Uniformity of traffic regulations, licensing of all automobile operators and the building of secondary highways were named as the three major requirements of the motorists of the United States at the annual convention of the American Motorists' Association, held at Philadelphia, Pa., March 15-16.

A comprehensive program, embracing all together fifteen problems of primary importance to the motorists of the country, was adopted by the national motoring body at the conclusion of its two-day session which, in addition to the three already named, included wider state highways; by-pas sroutes diverting through traffic around congested cities; employment of traffic circles, rather than intersections, wherever possible, regional highway planning; abolition of railroad grade crossings where possible, and, where not practical, the installation of mechanical safeguards; placing of traffic bureaus, in large cities, under competent highway engineers; universal adoption of

the Hoover Model Traffic Code; elimination of solid tire vehicles from public highways; highway safety education in all public schools; ultimate acquisition by the public of all major toll bridges; Federal regulation of interstate bus traffic; and opposition to the fee system of fining motorists for traffic regulations.

The following are the newly elected officers of the association: President, J. Borton Weeks, of Philadelphia; Vice-Presidents: Si Mayer, Chicago; Joseph F. Cox, Brooklyn, N. Y.; Daniel T. McEnerny, New York; Charles H. Roth, Pittsburgh; G. Adams Howard, Washington; Victor Fisher, Atlantic City; C. F. Oehlmann, Denver, Colorado and F. L. Cleveland, Tampa. A. K. Merbreier, of Philadelphia, was elected Treasurer; Linnaeus L. Hoopes, Wilmington, Delaware, Secretary, and Thomas J. Keefe of Washington was re-elected General Manager. Dr. S. M. Johnson of Washington was chosen Chairman of the Good Roads Board and William S. Canning of Philadelphia, Consulting Engineer. Richard Henry Lee of New York City was unanimously chosen Chairman of the Board of Governors.

NEW YORK STATE CHAPTER
Associated General Contractors of America

The third annual convention of this association was held at Syracuse, N. Y., March 13 and 14, with a good attendance of contractors from all over the State. Business and technical sessions were held Wednesday and Thursday, and the annual banquet Thursday night. Officers were selected as follows: President, Louis Mayersohn, Albany, N. Y.; Vice-President, John H. Bolton, Bolton, Suits, Bolton & Gibbs, Watkins Glen, N. Y.; Secretary-Treasurer—Richard Hopkins, Albany, N. Y.

Directors to serve two years: Region No. 2, W. O'R. Hayes, Secy.-Treasurer, Utica Construction Company, Utica, N. Y.; Region No. 4, George W. Chambers, Rochester, N. Y.; Region No. 6, William A. Greenfield, Greenfield & Harding, Hornell, N. Y.; Region No. 8, M. J. Molloy, Molloy & Murray Contracting Co., Yonkers, N. Y.; Region No. 10, James F. Crampton, President, Crampton Bros., Inc., Great Neck, Long Island, N. Y.

SECOND PAN AMERICAN HIGHWAY CONFERENCE

The Second Pan American Highway Conference that was to have been held at Rio de Janeiro, Brazil, June 19-July 3, 1929, has been postponed until August 16-August 31, 1929.

BOOK REVIEW

The Smoke Nuisance.—A pamphlet by Samuel S. Wyer. 22 pp. Ill. Published by Fuel-Power-Transportation Educational Foundation, Columbus, O. Copies free.

This is a well written pamphlet going into some detail in regard to smoke production and control. The principal heads include the cause of smoke nuisance, what it does to a community, the public interest aspects of the problem, and how to prevent it.

PERSONALS

R. O. Cottingham, has been appointed Highway Superintendent for Colfax County, N. M., with headquarters at Raton.

H. Hobart Porter has been elected Chairman of the Engineering Foundation, joint research instrumentality of the Founder Engineering Societies, to succeed L. B. Stillwell, who has served since 1925.

Neil J. Bass, former state highway commissioner, was appointed city manager of Knoxville, Tenn., at a salary of $10,000. Mr. Bass succeeds Otto T. Roehl, who has been manager since October, 1927.

Andrew Wells Robertson of Pittsburgh, president of the Philadelphia Company, was unanimously elected chairman of the board of directors of the Westinghouse Electric and Manufacturing Company.

Fred R. Hogue was appointed city manager of Ashtabula, Ohio, to succeed James E. Breen. Mr. Hogue has served as city attorney, city solicitor and county prosecuting attorney. Ashtabula has had five managers since the plan was adopted in January, 1916. Mr. Breen was appointed January 1, 1928.

Herman H. Smith, formerly deputy chief engineer of the Board of Estimate and Apportionment, New York City, has been appointed chief engineer of the board to succeed Arthur Tuttle who was recently appointed consulting engineer to the board. Mr. Smith has been acting as chief engineer since Mr. Tuttle's appointment as consulting engineer last fall.

Park R. Huntington has resigned as project engineer of the New Mexico Highway Department to become Assistant Resident Engineer for Brown County, Texas, located at Brownwood. Brown County recently floated a bond issue of $1,650,000 which will be augmented by Federal and State aid.

Walter B. Hodges has been appointed city manager of Jackson, Mich., at a salary of $7,500, to succeed Fred R. Harris, who has resigned to enter the contracting business. Mr. Hodges is a nature of Jackson, and became city engineer of Jackson in 1917. In 1922 he resigned to become city manager of Daytona Beach, Florida. On January 1, 1927, Mr. Hodges returned to Jackson to become city engineer and assistant to City Manager Harris. Mr. Harris became city manager of Jackson in April, 1926. Mr. Harris was previously city manager of Escanaba, Michigan.

New Appliances and Equipment

Describing New Machinery, Apparatus, Materials and Methods and Recent Interesting Installations

New Mack Dump Truck Bodies

Mack Trucks, Inc., New York, now manufacture a line of standard dump bodies which covers the major portion of dump truck requirements. These bodies are built of No. 7 gage sheet steel, and are constructed to taper 4 inches from front to rear, a feature which insures rapid emptying of body, even with sticky material. The bodies have full length 6 inch running boards with round corner front, which makes for a smooth rub rail, full length of body, and provides a substantial front corner body bumper. Front headboard, tailgate posts and gate all extend well above the body sides proper so that sideboard extension and large opening tailgate are provided for.

The bodies all have manual tailgate operation and are also equipped with double acting tailgate at no extra charge. They may also be fitted with double acting tailgate chains with no extra expense. The bodies are substantially braced with under structures to prevent, as much as possible, the body floor from becoming wavy.

Ross Moldboard Snow Plow

The Batavia Steel Plate Construction Co., Batavia, N. Y., manufactures the Ross snow plow which, it is claimed, is especially designed to throw and spread the snow; it does not pile up shoulders of snow. Working like the moldboard of a farm plow the Ross will clear all kinds of snow formation encountered on street or highway. The moldboard shape of the plow permits of a wide cut where wanted or it may be adjusted to suit the needs of the road. The way that heavy loads of snow are handled shows that the Ross does not push the snow or pack it ahead, but rolls it off to the side.

The Ross cutting blade is a separate unit of highly tempered steel having two edges which may be reversed as desired, thereby insuring long wear. The point seam of the moldboard is electrically welded thus adding strength and wear-resisting qualities. The only wearing parts are slow-wearing. These are the carrying shoes, which are adjustable for wear, and the cutting blade of manganese steel, which may be reversed or turned over for even wearing and double life.

MACK STEEL DUMP BODY

The Ross Plow has been planned so that it can be attached to all types of modern motor trucks. The method of affixing the push frame to the truck is through a suspension guide on the front axle which gives it flexible action. The only point of rigidity to the truck is at the point of contact at the rear axle where the push frame is securely U-bolted to the rear springs and comes in contact with the spring pad situated between the rear axle housing and the springs. This is the correct method of attachment of a snow plow to a motor truck and is found only on Ross Plows, it is claimed.

New "Caterpillar" Fifteen Tractor

The Caterpillar Tractor Co., San Leandro, Calif., and Peoria, Ill., announces the "Caterpillar" Fifteen as ready for delivery, price $1500, f. o. b. Peoria. The Fifteen completes the "Caterpillar" line of small tractors, giving the farmer and contractor three sizes aimed to fill his need for a track-type tractor.

From the engineering standpoint the Fifteen is a duplicate of the Ten, which has just gone into production at the new Peoria factory.

Just a litle bigger than the Ten, it is a replica of it except in size and power. In fact, when the three—Ten, Fifteen and Twenty—were lined up in order at a recent Peoria convention for the dealers' observation, they provided a harmonious line of power for any construction job within that range.

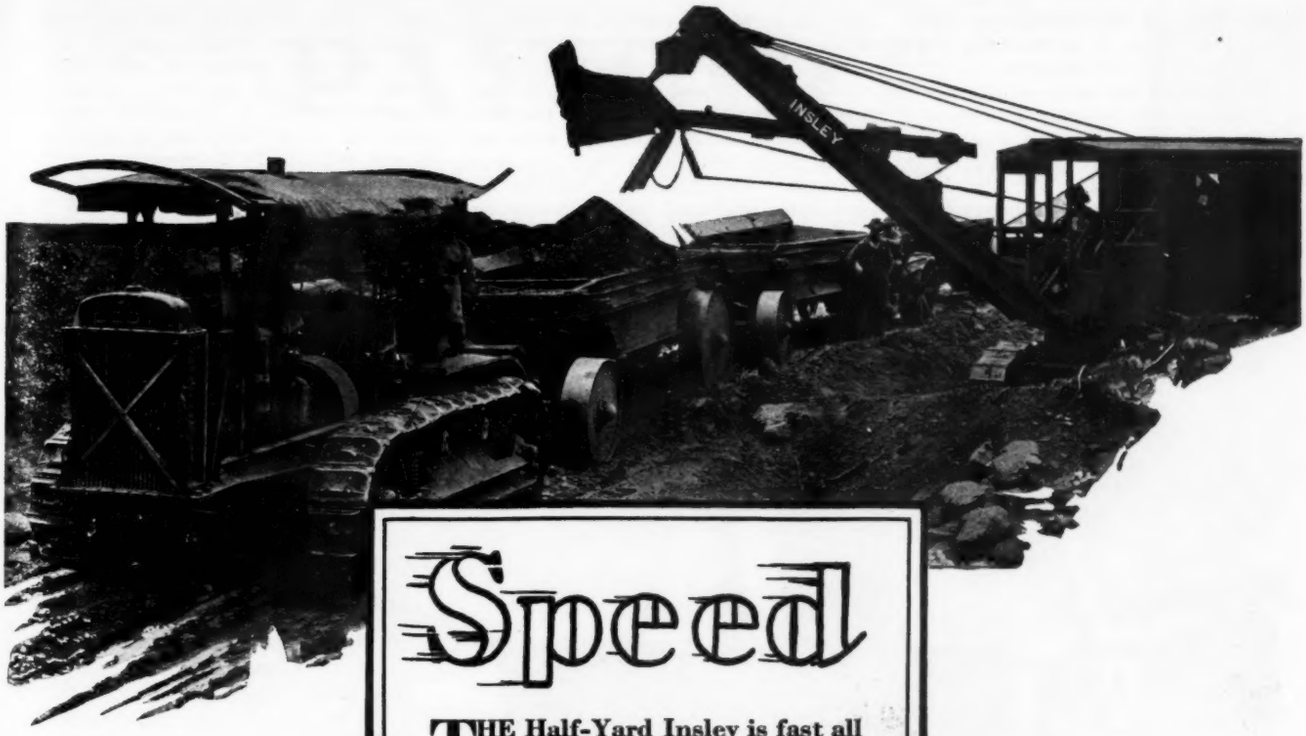
Mercoid Controls for Pumps

The American Radiator Co., Accessories Division, New York, has developed mercoid controls, which may be described briefly as instruments which automatically make and break an electric circuit according to changes in pressure, vacuum, or temperature. The outstanding features are reliable close control and the carrying of full line current, 110 or 220 volts, in sufficient volume to operate many electrical units direct, but without oxidation or corrosion of the contacts. There is no exposed arc,—a vital feature where an open arc might increase the fire hazard. The power elements or means for operating the switch are of either the bellows type or the Bourdon Spring type —whichever is best suited to the operating conditions.

The mercoid switch consists of a glass tube in which are sealed leads of special material. A quantity of mercury makes or breaks the circuit when the tube is

ROSS MOLDBOARD SNOW PLOW

NEW CATERPILLAR FIFTEEN



Speed

THE Half-Yard Insley is fast all through. Its line speed is high, yet it has ample power to pull the bucket through hard material. Each drum shaft is mounted on roller and ball bearings, cutting down the loss of power to a minimum.

It has a rapid swing—5 r.p.m. High line speed and fast swing combine to make high operating speed in the Insley—three and four passes a minute under average conditions. Ample power enables this speed to be maintained in hard digging.

It has two travelling speeds enabling it to get on and off the job in a hurry.

These three factors of high speed operation—line speed, swing and travelling speed—account for the fact that the Insley, a half-yard machine, is capable of handling a daily average in excess of three hundred fifty yards over long periods of time. And this operating speed more than any other one factor accounts for the fact that the Insley is a money maker.

INSLEY

The Insley is made as a full revolving machine, Type "R", and likewise with a 210° swing, Type "C".

718

INSLEY MANUFACTURING CO.
INDIANAPOLIS, INDIANA
Division of National Equipment Corporation

tilted. There is no oxidation or corrosion. The contact is permanently clean and instantaneous in operation.

The single circuit switch is used where it is desired only to make and break a circuit, such as to start and stop a motor. Mercoid controls using this switch can be furnished either to make circuit on increasing pressure or temperature, or to break circuit on increasing pressure or temperature.

MIAMI BULLDOZER WITH CLETRAC 30-A

The two circuit switch is used where it is desired to make circuit alternately on both increasing and decreasing pressure or temperature. When used for a three wire circuit, the two center leads are joined. All mercoid controls to be used in combination with the Arco Motor Valve must be equipped with two circuit switches. This switch is also used where it is desired to sound an alarm when one circuit breaks.

The Double Pole Switch is used to make and break a circuit where three phase current is employed. It is also used to make and break two separate circuits. It can be furnished either to make or break on increasing pressure or temperature.

When Mercoid Pressure Controls are used on sewage lift stations, there are no floats or rods, no open contacts. The circuit is opened and closed by the Mercoid Switch. These stations can be controlled by head pressure because the Mercoid Control can be adjusted to make and break circuit with only a slight change in pressure. The instrument can be adjusted for any make and break between 10" vacuum and 10 lbs. pressure. The "differential" is also adjustable, for control as close as 1 lb. or as wide as 9 lbs (or the mercury column equivalent.) It is furnished either to make or break circuit with increase of pressure.

This type of installation can be used for sump pumps of all kinds and for general control of liquid levels, to control pumps, to control flow (through the use of the Arco Motor Valve) and to sound alarms or indicate high and low limits.

Housing for Construction Workers

The Chicago Road Machinery Co., Chicago, Ill., manufactures Cor-Mac sleepers for use in construction jobs. The standard units are sixteen feet long, seven feet wide, and seven feet high. They are divided into two compartments, each being equipped with four steel wire spring cots, each thirty inches wide and six foot six inches long. Each cot is furnished with a mattress. Other units can be arranged to suit individual requirements.

Each unit is painted inside and out —red running gear, and French grey bodies, and lettered with the contractor's name and address, and unit number.

There is provided for each cot, a closed locker thirty inches long, eighteen inches wide and twelve inches high for personal effects.

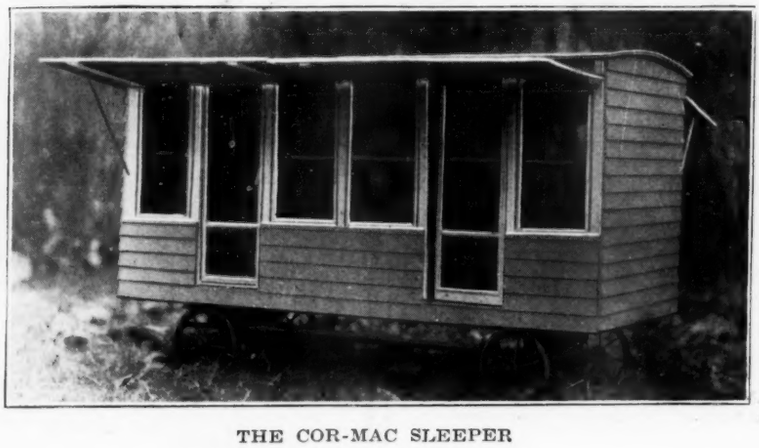
The units are screened on both sides, with hinged storm sides, that can be opened to any desired height, thus affording light and air as wanted.

Cor-Mac Sleeper units are mounted on a heavy hickory, steel reinforced running gear, with heavy 4-inch tired steel wheels of a carrying strength of two and one half tons with tractor hitch.

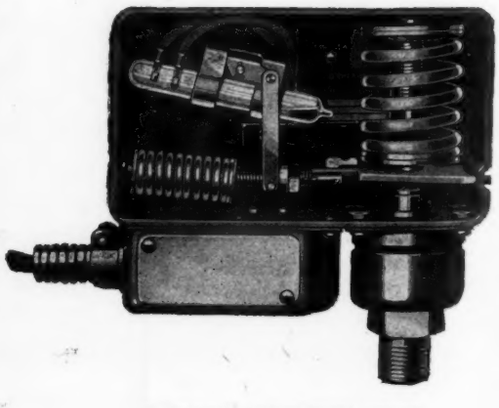
A New Miami Earth Moving Combination

The Miami Trailer-Scraper Co., Troy, O., has announced a new power operated bulldozer for the Cletrac 30-A which attaches to the standard Cletrac extended axle. A number of improved features have been incorporated in this bulldozer. Since it is entirely independent of the tractor drawbar it does not interfere with the free use of the tractor as a pulling unit, and for similar purposes. The 7-foot bulldozer blade is carried on heavy "H" beams; it is raised and lowered by two steel cables attached at the ends to insure an even lift in places where one end only of the blade is under load. Suitable rub plates eliminate all side movements. A distinctive feature also is the clever mounting of the "A" frame (which carries the cables) by means of a universal connection direct to the track frame, thus allowing the blade to follow ground contour, minimizing any tendency of the blade to "gouge."

The Miami power winch manufactured for use with this model is so designed that the same winch which operates the bulldozer is also available for power use with the Miami One-Man power scraper, Miami power dump trailers and the Miami backfiller, as well as the ordinary

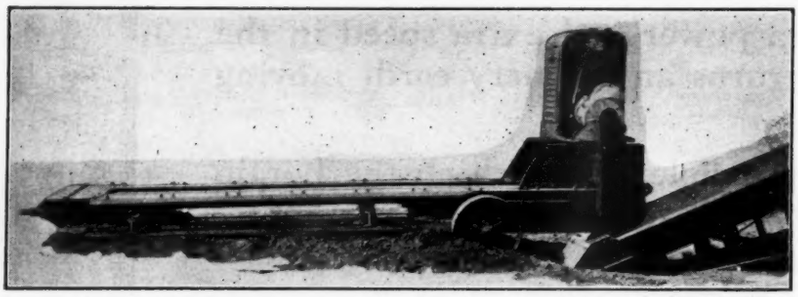


THE COR-MAC SLEEPER



MERCOID CONTROL UNIT

winch uses. The Miami winch drives from the power take-off of the tractor with a double roller chain, through a multiple disc clutch designed, integral with an over-running brake which permits the tractor operator, by means of only one lever to control all movements of the load.



BARBER GREENE BELT FEEDER

This equipment combination provides a tool for every phase of earth moving activity. The Miami Company is now engaged in producing similar equipment for a number of various tractor makes and models.

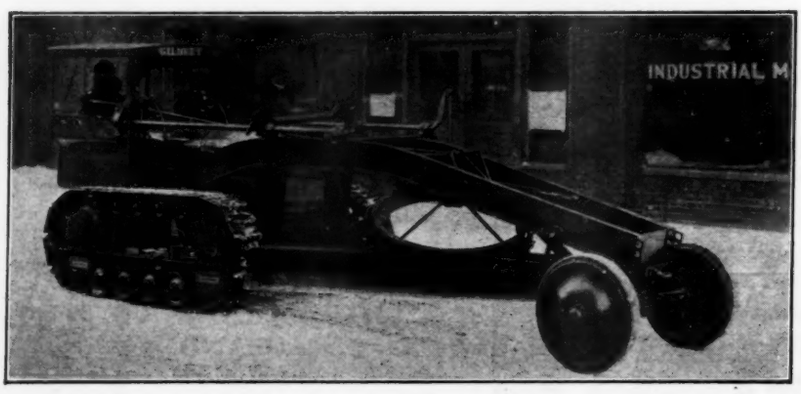
Barber-Greene Belt Feeder

The Barber-Greene Company, Aurora, Ill., has announced the new B-G belt feeder. This is designed to facilitate the unloading of material such as sand, gravel, slag, crushed stone, coke, hard coal, cinders, iron oxide, fine ore, moulding sand and any other free flowing material usually transported in hopper-bottom cars. The use of this machine will eliminate the necessity of constructing a pit under the railroad tracks. This is an expensive item, and must be approved by the railroad. A small pit on the outside of the railroad track for the conveyor hopper under the discharge end of the gravel feeder is all that is needed.

The use of a B-G feeder will speed up the unloading of material from hopper-bottom cars. It will control the flow of the material within the capacity of the conveyor. It will protect the conveyer and especially the belt from over loading and damage, thus increasing the life of such equipment. With this new belt feeder it is possible to unload an entire car of free flowing material without shoveling. The machine may be used either over the rail or under the rail as required. The maximum thickness through the feeder frame, including the top sliding plate, is 4 1-16 inches. Either an electric motor or gasoline engine can be used to drive the feeder. The machine gasoline driven weighs 1,690 pounds and electrically driven 1,520 pounds.

Trackson and Gilbert Grader Unit

The Trackson Co., Milwaukee, Wisc., and the Gilbert Mfg. Co., Stillwater, Minn., have brought out a new unit, the Model DH Trackson and Gilbert grader, that meets the requirements for a heavy-duty, one-man motor patrol, and at the same time provides a crawler tractor which may be made quickly available for other kinds of work. The speed and simplicity of either mounting or detaching the grader and the quick interchangeability of the Trackson McCormick-Deering are the most important advantages of this unit. There are no special parts necessary for the installation, and it is only about a four-minute job to remove the grader from the tractor, leaving a complete, crawler-equipped power plant which is adapted to a large variety of jobs.



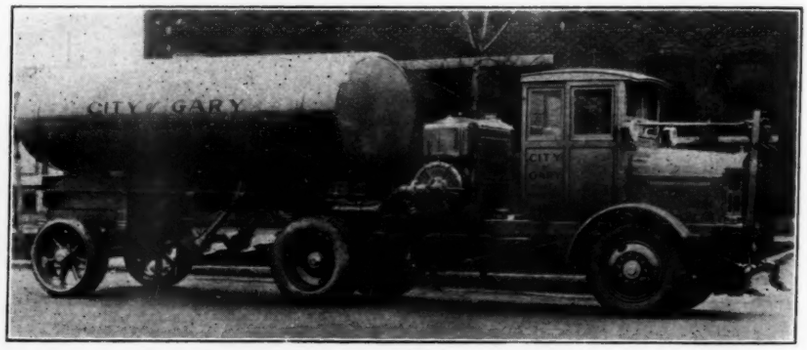
TRACKSON McCORMICK-DEERING AND GILBERT ONE-MAN GRADER

With the grader detached, the Trackson may be employed on such work as hauling dirt, rock, and other materials. Or, it may be equipped with other auxiliary attachments such as loaders, shovels, hoists, cranes, bulldozers, etc. Because of this versatility one Trackson McCormick-Deering can be made to serve for three of the four seasons as a road work and general utility tractor, and during the winter may be equipped with a heavy-duty snow plow to keep the roads open to motor traffic.

The Trackson Company also manufactures a lighter crawler for the McCormick-Deering Industrial Tractor, which is likewise adapted to road work, general construction, snow removal, etc.

An All-Around Unit for Street Work

The Four Wheel Drive Auto Company, Clintonville, Wis., recently manufactured for the Department of Streets, Gary, Ind., a street flusher equipped to do a number of special jobs.



F W D ALL-AROUND UNIT FOR STREET WORK

The primary purpose of the unit is to keep the streets of the city clean by flushing in the summer and by removing the snow in the winter. Only a half hour is required to install the blade snow plow to the frame provided on the front of the truck. As the blade snow plow is manually controlled from the cab, it can be used very economically as a road grader or maintainer, as well as a snow removal unit. Its ability as a fire fighter is invaluable. It comes particularly handy when there is a grass fire, a burning dump or some similar situation to look after because it can carry 3,000 gallons of water beyond the fire limits and act as a patrol, thus relieving the regular fire department. The suction hose and so-called filler attachments permit the emptying of flooded basements and of stagnant pools of water.

When the sewer inlets clog, the machine may be used to open them up. In the summer time the sprinkler attachments make it possible to keep down the dust on gravel streets. The unit also may be used for road oil distribution.

Saves Cable Wear

NO excessive wear because of disalignment of boom and cable with the Koehring — a big saving in maintenance costs!

The Koehring swivel boom-point fairlead always aligns itself with cable; saves cable wear at every bucket trip!

FingerTip ease **of control and no loss of the *"feel"* of the load:**

That's because there are no mechanical devices intervening between the load carrying clutch and the hand of the operator.

The Koehring has FingerTip ease of control, not because of mechanical aid to shift clutches, but because Koehring double outside, self-equalizing clutches have the frictional area to make handling easy . . . . . Koehring "feel" of the load with FingerTip control means confident, accurate high speed operation.

Write for Bulletin D. L.-14

Dragline Capacities

Quickly convertible to shovel, pull shovel or crane. Swiveling boom-point fair-lead, and extra wide and long multiplanes optional.

No. 301 — ¾ yd. bucket on 40' boom. Other sizes at proportionate boom lengths. Wisconsin 4 cylinder gasoline engine, 5¼"x 6½", 1000 R. P. M.

No. 501 — 1¼ yd. bucket on 45' boom. Other sizes at proportionate boom lengths. Wisconsin 4 cylinder gasoline engine, 6"x7", 1030 R. P. M.

No. 601 — 1½ yd. bucket on 45' boom. Other sizes at proportionate boom lengths. Wisconsin cylinder gasoline engine, 6"x7", 760 R. P. M.

KOEHRING COMPANY

MILWAUKEE, WISCONSIN

PAVERS, MIXERS—GASOLINE SHOVELS, PULL SHOVELS, CRANES AND DRAGLINES

Sales Offices and Service Warehouses in all principal cities

Foreign Department, Room 579, 50 Church Street, New York City

Mexico, F. S. Lapum, Cinco De Mayo 21, Mexico, D. F.

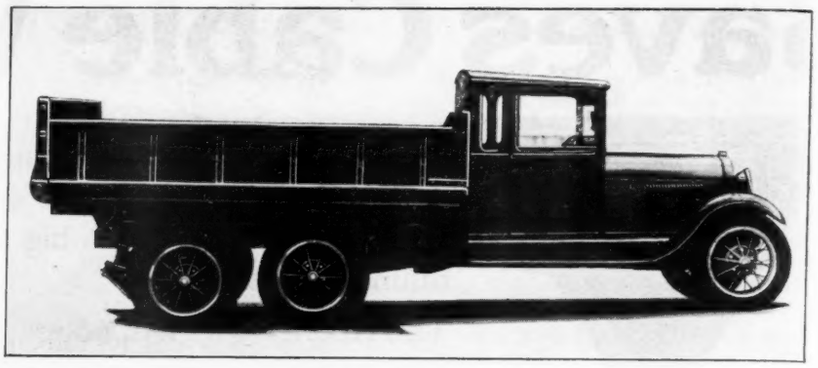
Division of National Equipment Corporation

A 5056-1

Additional Twin-Flex Model

The Twin-Flex Corporation, Detroit, Mich., has announced a new model 6-wheel Tandem Truck. This differs from the standard Twin-Flex practice only in the tread of the rear wheels, which are placed in line instead of overlapping, and in the spacing between the rear axles. The new model permits a maximum platform length of twelve feet.

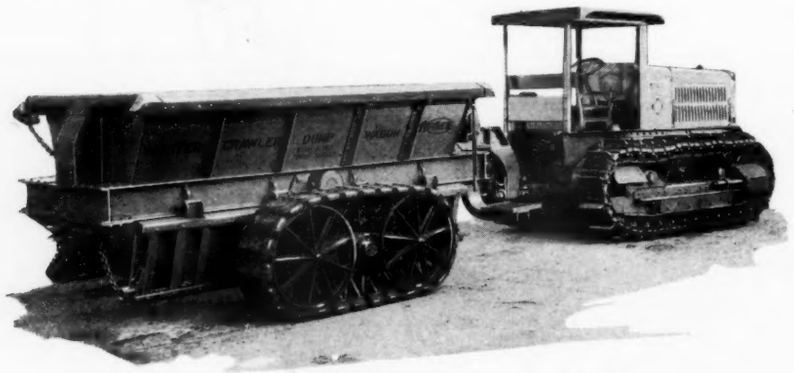
The Twin-Flex is a unit that transforms the model AA Ford truck into a six-wheel three-ton vehicle that will go anywhere that a Ford truck can be driven and carry its load safely and economically. It is being marketed through Ford dealers, with distributors in prominent cities.



NEW MODEL TWIN-FLEX TANDEM TRUCK

The Good Roads "Motograder"

The Good Roads Machinery Co., Inc., Kennett Square, Pa., has brought out the Good Roads "Motograder," which is a heavy grader attachment especially designed for use with the Model 20-K Cletrac tractor as the power unit. This machine has many refinements in steering, blade control, balance against side slippage, freedom from blade chatter, and ease of operation. It is equipped with a most effective scarifier with quick acting and powerful control. The blade length is 8 feet, but longer blades are available; the circle is of boiler plate, 1 inch thick, accurately turned and heavily braced. The moldboard counterbalancing arrangement is such that the spring tension is always equal to the weight of the bar, regardless of its position. The overall width is 5½ feet; the overall length 19 feet, and the total weight fully equipped 10,860 pounds.



AUSTIN 5-YARD CRAWLER DUMP WAGON

Western 5-Yard Crawler Dump Wagon

The Austin-Western Road Machinery Co., Chicago, Ill., manufactures crawler dump wagons in all practical sizes. To meet the demand for a crawler wagon that can be handled economically by a 30-horse power tractor, a Western wagon of 5 cubic yards capacity has been developed. It is a very strong, all-steel wagon of the same general design as the larger wagons but differing in two important particulars.

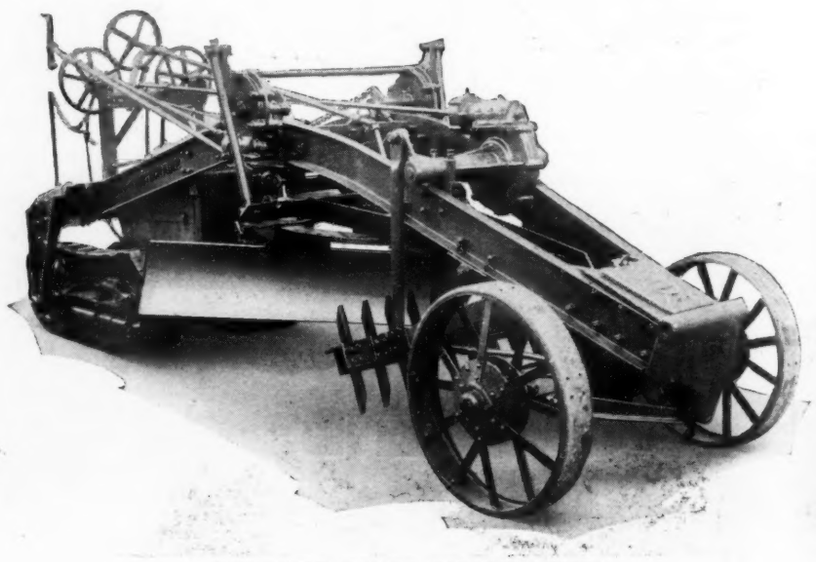
This wagon has no front truck, the front end being attached directly to the tractor. The load is balanced on Athey truss wheels of ten tons capacity. It has only one set of bottom dump doors, instead of two, controlled by two levers, one used for dumping and the other for closing the doors. The 5-yard Western crawler wagon can be handled easily in single units of 30-horse power tractors. Two or three 5-yard wagons in train formation can be handled by a large tractor when hauling conditions permit. Should conditions suddenly change, there is an advantage in being able to drop one unit and still continue operation, hauling a large yardage. There are times also when the direct tractor hitch is advantageous.

In this wagon, as in the larger sizes, the rear draw bar is a heavy steel casting to which a second wagon can be hitched when it is desired to operate the wagons in trains. This rear draw bar casting is furnished on all Western crawler dump wagons.

Westphalt Hot-Lay Asphaltic Pavement

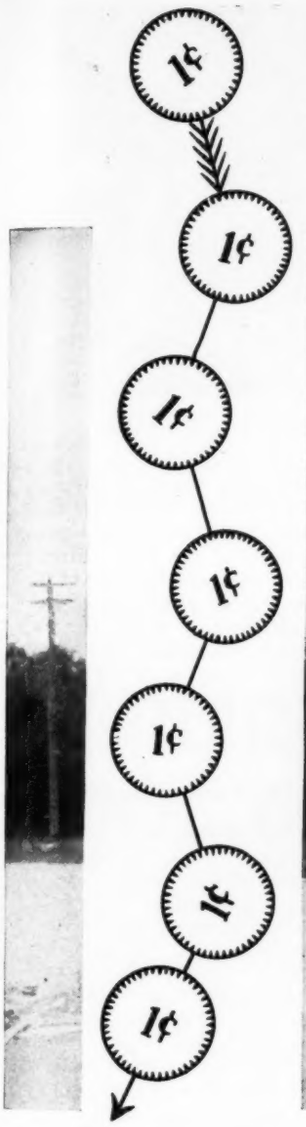
The West Process Pavement Co., Louisville, Ky., has introduced a new type of asphaltic pavement, called Westphalt. Westphalt is a stone-filled sheet asphalt mixture and consists of a hard properly graded mineral aggregate composed of such materials as stone screenings, broken slag, mine tailings, crushed and uncrushed gravel and sand uniformly mixed with a mineral filler and unblended asphalts so proportioned that, when blended by heating the mixture just prior to laying, a true asphalt cement is formed, binding the mineral aggregate together.

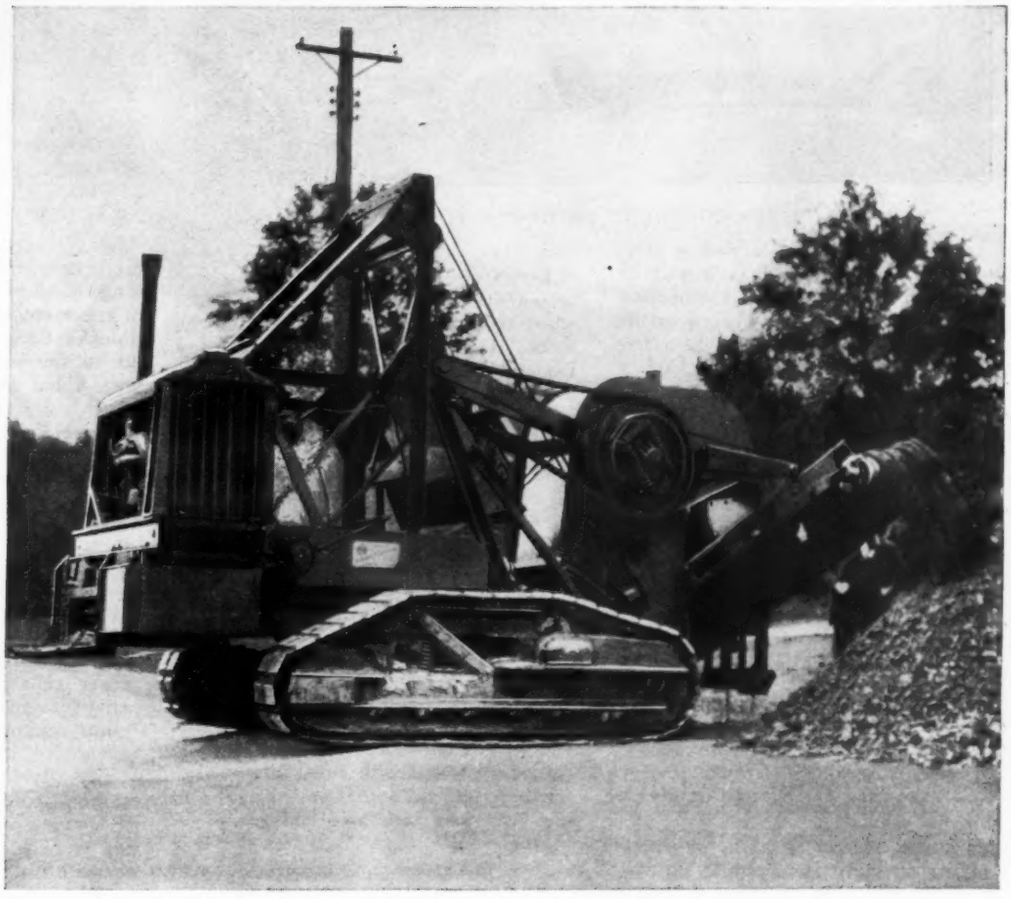
Westphalt is shipped as a loose, uncompacted granular mixture prepared at centrally located plants and shipped in open top freight cars or delivered



THE GOOD ROADS "MOTOGRADER"

On 15 Different Ditching Jobs 10,000 Feet Through Hardpan





7¢ Per Foot

Opr. 70 Days	$538.78
Gas	120.17
Oil	6.80
Truck Time	162.50
Other Labor	46.46
Moving Machine	402.50
Depreciation at 20%	756.00
Int. at 6%	226.63
Repairs	358.46
Extra Labor	178.60
Total	$2,796.90
Cost per foot is $2,796.90 ÷ 39,147	0.072

Accurate cost figures kept by the City of Seattle Water Department show how Barber-Greene Ditchers cut costs even on small jobs where the digging is exceedingly tough and moves are frequent.

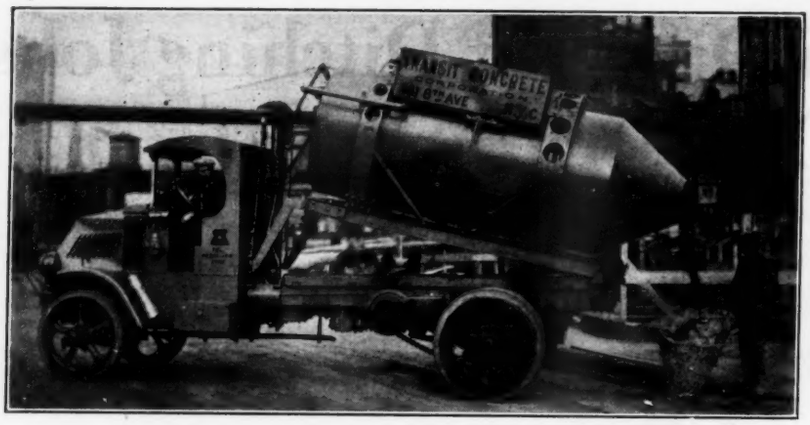
Over a period of 70 working days, this Barber-Greene opened 39,147 feet of trench, on 15 different jobs—digging 10,000 feet through hardpan.

The expense of moving the ditcher from one job to another equalled almost one-third of the total ditching cost. But even including this expense, in addition to gas, oil, depreciation, maintenance, the operator's time, and other items listed, the average cost per foot of trench dug was only seven cents.

If you would like to see how others are licking high ditching costs, in some instances driving them as low as three cents per foot, send for your copy of "Ditching Snapshots and Records."

BARBER-GREENE COMPANY
635 W. Park Avenue Aurora, Illinois

BARBER B G STANDARDIZED MATERIAL-HANDLING MACHINES **GREENE**



MIXES CONCRETE EN ROUTE TO JOB

CLARK METER BOX AND KEY

in trucks and may be carried in stock piles as long as desired as it will not alter, deteriorate or compact objectionably by exposure. It is heated on the job, just prior to being laid, to a temperature between 275° and 350° F. The heating may be done in any suitable heater of the pan or cylinder type directly or indirectly heated by an oil burner or in a non-tilting concrete mixer equipped with a suitable oil burner of sufficient capacity. The hot material is then shoveled into place, spread to the proper depth to give 1½ or 2 inches in thickness after compression, raked and rolled in the usual manner.

Westphalt enables the small contractor to become a "hot-mix contractor" without a "hot-mix plant." It makes it possible for small cities and towns having no hot-mix plant to have hot laid asphaltic pavements even though the yardage required at any one time be small.

It makes hot-lay asphaltic pavements possible on state and county highways at points many miles from a hot-mix plant. It assured a uniform, durable and resilient asphalt pavement at a reasonable cost.

The Paris Transit Concrete Mixer

Transit Mixers, Inc., San Francisco, Calif. manufactures the Paris Transit mixer which mixes concrete on the way to the job, eliminating the central mixing plant. The mixer is mounted on a truck. It is charged with aggregate and cement at the material bins and water is added when and as wanted from a tank on the truck. It is stated that practically any modern material plant can be arranged to charge these mixers, and that their use results in a greatly lowered overhead.

Barber-Greene New Light Car Unloader

The Barber-Greene Co., Aurora, Ill., has announced a new light car unloader for unloading hopper bottomed cars.

This small light car unloader has a capacity of a ton a minute. It is only 3⅝" thick over the rails, allowing ample clearance for the largest hopper doors, and weighs only 1,700 pounds. The machine is powered with either gas or electricity as desired and is so balanced that one man can raise one end easily for moving.

Clark Meter Box and Long Handled Key

The H. W. Clark Co., Mattoon, Ill., makes the Clark No. 16 meter box and a long handled meter box key.

The meter box is 16 inches in diameter and 16 inches deep with a full opening. The lid is equipped with an improved lock of special rust-proof design. With this system of setting meters, the meter boxes are placed in a straight line in the parkway as close as practical to the sidewalk. The meter reader inserts the end of the long handle key in the hole in the lid of the meter box. A twist of the wrist unlocks the box, and the lid is lifted off to the side. The key is provided with a lug on the side which may be used to flip back the lid of the meter. A chisel point on the end of the key is convenient in scraping away mud or dirt which may accumulate around the lid.

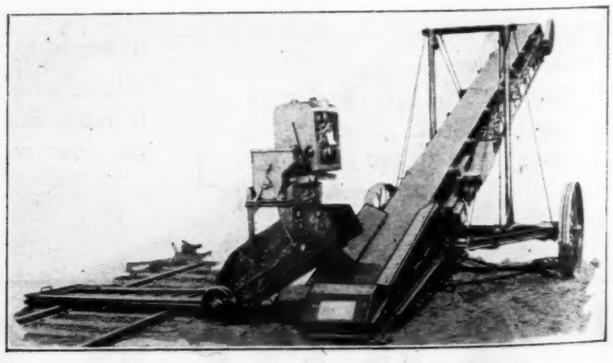
New Evinrude Twin Centrifugal Pump

Evinrude Motor Co., Milwaukee, Wisc., has announced an entirely new, larger capacity, twin motor equipped, self-contained pumping outfit. This pump incorporates the features of portability, low cost operation and capacity. It fills a definite need for contractors confronted with the problem of moving excess water from ditches and trenches, supplying pavers and mixers with water and other jobs. In commercial water transporation this pump becomes very effective when quarters too small to handle a large diaphragm or bilge pump present a problem of excess water disposal. Dredging companies and barge lines will find this centrifugal pump of value, for it is highly portable and requires little space.

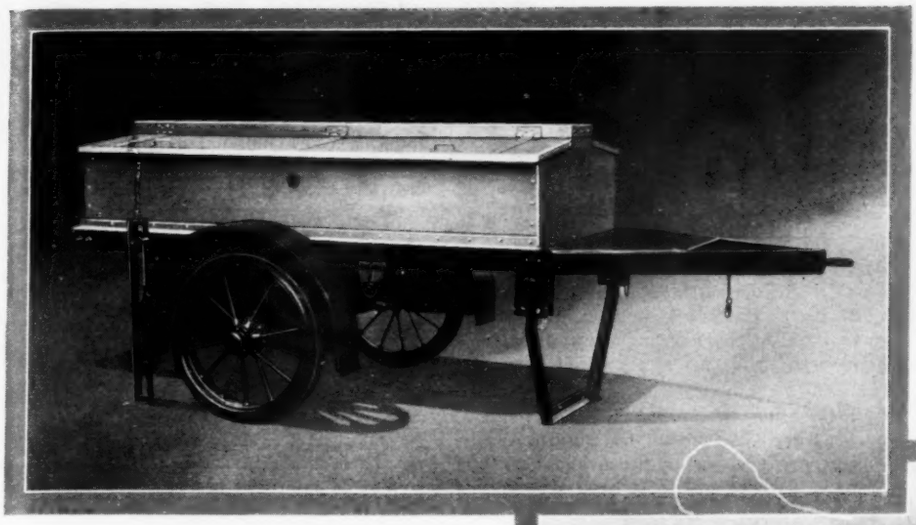
This new pump is powered by the Evinrude 6 h.p. "Fleetwin" motor. It weights slightly over 100 lbs., making the outfit truly portable and increasing its field of usefulness.

A feature of the new pump is its

LAYING WESTPHALT PAVEMENT

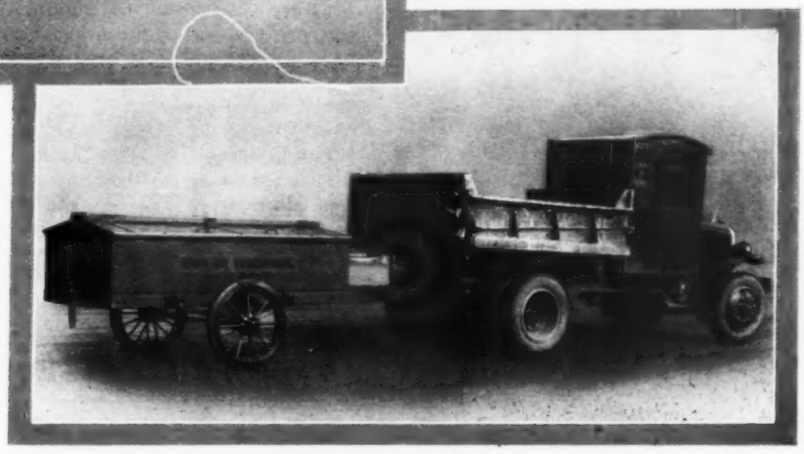


BARBER-GREENE SMALL UNLOADER



Ten of these modern All-Steel Portable Tool Boxes have just been added to the Cincinnati Department of Highways. They are designed for highway maintenance work and meet every requirement for such work.

Here is a very good reason why Cincinnati is buying more Littleford Tool Boxes. The All-Steel Box shown behind the truck has received two years' hard service and—well, just look at it!



CINCINNATI ORDERS NEW TOOL BOXES

There is nothing like new equipment to spur a highway department to hard work. And the Cincinnati Department of Highways is starting 1929 with ten new Littleford All-Steel Portable Tool Boxes—Squeegees, hoes, rakes, shovels and all other equipment needed in street maintenance work can be easily transported from one job to another and safely stored and locked at night.

The Box

This All-Steel Heavy Duty Tool Box has a double flanged cover that is absolutely water tight. Inside measurements of box are: 45 inches wide, 8 feet long, and 24 inches high, sloping to 29 inches in the center. The bottom is strongly reinforced with angle stiffeners—heavy tools can be dropped in without injury to box.

A large inside shelf, placed about half way down the box, extends from one end to the other and affords convenient space for small tools and equipment. On the outside and just in front of the box is a strong bench having a working area of 8 square feet.

The Chassis

The tool box is mounted on our spring cushioned two-ton trailer. 44" semi-elliptical springs—32" x 5" rubber tired wheels fitted with Timken roller bearings—high carbon steel axle and non-collapsible drop legs are excellent reasons why this outfit will stand up under all the abuse a highway gang can give it.

Write for our new Bulletin No. E-11. It completely describes Littleford All-Steel Tool Boxes.

LITTLEFORD BROS.

452 E. Pearl St. *Cincinnati, Ohio*

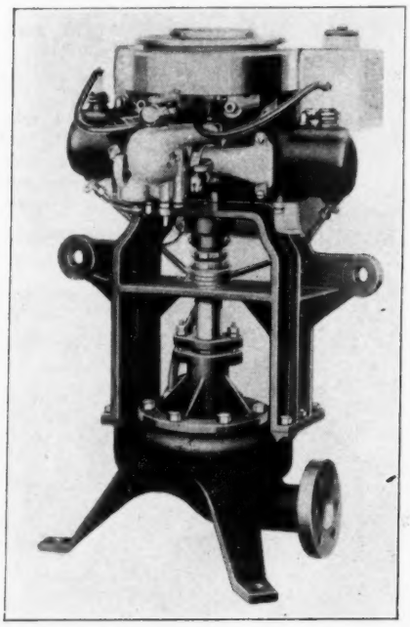
THE SIGN OF LB A GOOD HEATER

LITTLEFORD

ROAD & STREET MAINTENANCE EQUIPMENT

LITTLEFORD KETTLES SINCE 1900

very great capacity. Notwithstanding the fact that the pump is no larger than a small keg of nails, it is capable of pumping 15,000 gallons of water an hour and will operate under a head



EVINRUDE TWIN CENTRIFUGAL PUMP

of 50 feet. The operating cost is claimed not to exceed 15c. per hour or 1c. per thousand gallons.

The pump has but one moving part, the bronze impeller, directly splined to the alloy steel shaft.

New Chain Belt Centrifugal Pump

The Chain Belt Company, Milwaukee, Wis., has announced the addition of a centrifugal pump to its line of Rex contractors' equipment. This pump is made in three sizes with capacities of

CHAIN BELT REX PUMP

325, 650 and 800 gallons per minute respectively on a total head of twenty feet. The features of these pumps are an open type impeller, which allows the handling of dirty water; an automatically lubricated center bearing; the same size suction and discharge flanges, allowing the use of the same size hose for both; and a unit construction which provided absolute alignment and rigidity. The addition of this pump to the Rex line makes the line most complete and includes single and double diaphragm pumps, single and double plunger force pumps, and a road pump.

CIVIL SERVICE

Structural and Construction Engineer.—Applications will be received until April 24 for architectural, structural, construction and mechanical engineers, at salaries ranging from $2,600 to $3,200 per year.

The examinations are to fill vacancies in the Office of the Supervising Architect, Treasury Department, for duty in Washington, D. C., or in the field. Competitors will not be required to report for examination at any place, but will be rated on their education, training, and experience.

Full information may be obtained from the United States Civil Service Commission, Washington, D. C., or the secretary of the United States Civil Service Board of Examiners at the post office or customhouse in any city.

TRADE PUBLICATIONS

Flexible Road Joint Machine.—36 page, 41 illustrations, showing the Flexible Road Joint Machine as applied to various types of modern road construction—namely: new concrete, re-surfacing old concrete, re-surfacing old macadam, re-surfacing old brick pavements also for the construction of concrete base courses, for flexible top and brick surfaced roads. Flexible Road Joint Machine Co., Warren, O.

Snow Removal.—Snow removal and Caterpillar Tractors, 48 pages, illustrated. Discusses snow removal, drift prevention, and lists many kinds of snow fighting equipment. Caterpillar Tractor Co., San Leandro Calif.

Water Works Brass Goods.—A most complete line of brass water works equipment is described and illustrated. Grabler-Republic, Inc., Cleveland, O.

Track-Wheel Wagons—Euclid track-wheel dump wagons, made in 5½, 6, 7, and 8-yard sizes, are described and illustrated in detail in the Euclid Wagan Catalog. Charts of haulage equipment on dirt moving are of interest and value. Euclid Wagon Co., Euclid, O.

Koehring Paver.—16 pages, illustrated describing the Koehring new 27E paver. The Koehring Co., Milwaukee, Wis.

Tractor Power Shovels.—The Bay City tractor shovel is described in Catalog T-5, and the advantages of its convertible features illustrated. Catalog R-2 illustrates the Model R, full-revolving shovel. Bay City Shovels, Inc., Bay City, Mich.

Cranes—"The Story of a ½-yard Machine," being the history of the development of the Universal truck crane. The Universal Crane Co., Lorain, O.

Crawler Tractor.—The Cleveland Tractor Co., Cleveland, O., in an interesting booklet describes the use of "Cletrac" crawler tractors in every construction field.

Sump and Centrifugal Pumps.—American Well Works, Aurora, Ill., have put out bulletin No. 197, describing double suction centrifugal pumps; No. 204, describing sump pumps; and No. 195, covering single stroke, completely enclosed power heads.

Sand and Gravel Equipment. — The Good Roads Machinery Co., Inc., Kennett Square, Pa. Describes and illustrates a wide variety of sand and gravel equipment. 80 pages, illustrated.

Concrete Mixture.—Quality control of concrete is rapidly becoming standard practice. A simple, practical method for producing concrete of definite quality to meet a wide range of requirements is given in the latest revised edition of "Design and Control of Concrete Mixtures." No involved calculations are necessary for satisfactory results. In this edition a specification for concrete based on the 1928 Building Code Regulations of the American Concrete Institute is included. The book also gives the A. S. T. M. tests used in the field to control concrete and shows how to obtain high-early-strength concrete and watertight concrete with standard portland cement. Portland Cement Association.

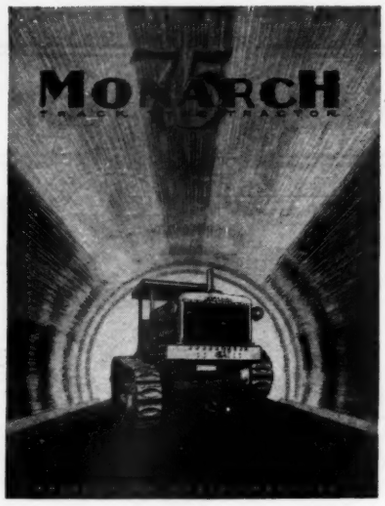
Bituminous Distributing Equipment.—The Good Roads Machinery Co., Inc., Kennett Square, Pa., describes and illustrates the Good Roads "Champion" distributor, which is claimed to represent the very latest development in the mechanical application of tar and asphalts to road use. 48 pages, illustrated.

Concrete Breakers.—The Sullivan Bulletin, 81-v, 8 pages, describes briefly the new Sullivan 76-lb. Concrete Breaker, type K-2. These Busters are intended for general or all-round pavement breaking or concrete breaking work. They are powerful, quick acting, and sturdy. The bulletin is illustrated with numerous pictures of the machine in operation. Sullivan Machinery Co., Chicago, Ill.

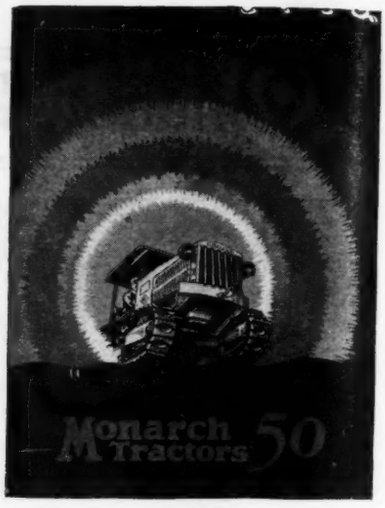
INDUSTRIAL NOTES

Colprovia Roads, Inc., has been formed to handle the Colprovia cold bituminous road surfacing process which has been introduced in the United States and Canada during the past two years, with offices at 52 Broadway New York City.

Donald Williams has been appointed assistant sales manager of the Dow Chemical Co.



MONARCH "75" CATALOG



MONARCH "50" CATALOG

The Allis-Chalmers Mfg. Company have pubilshed catalogs describing their Monarch "50" and "75" Tractors. These catalogs tell about these models in a pleasing and readable manner, by actual photographs, and instructive diagrams. Allis-Chalmers will send copies of these catalogs upon request from Springfield, Ill.

R. A. Shilbauer, for the past several years assistant advertising manager of the Chain Belt Company, has been appointed advertising manager.

The Wm. H. Ziegler Company of Minneapolis, Minnesota, is opening up a branch office in Fargo, North Dakota. This office will be in charge of O. H. Strand, who will represent Barber-Greene Bucyrus Erie, Chain Belt, Sterling Wheelbarrow, Williams Buckets, Plymouth Locomotives, Butler Bins, etc.

An increase of FWD truck sales for the year 1928 of 24.3 per cent over the sales of 1927, has been announced by the Four Wheel Drive Auto Company. This increase in sales was made over the increase of 45.5 per cent and 57.2 per cent for the past two years; 76 per cent of the FWD trucks sold were to previous owners of FWD equipment, according to the announcement. The FWD Company during the past year confined their sales to the State, County, Municipal and Township Highway Departments, public utility companies, fire departments, oil fields, contractors and general haulers.

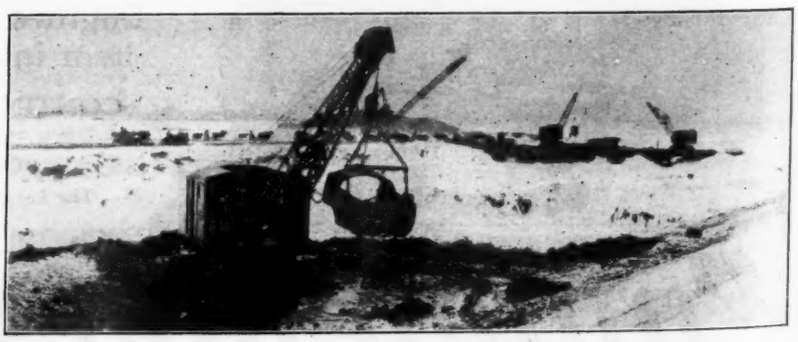
The Phoenix Meter Company, organized in 1914 and incorporated in 1925, has recently been re-organized and is planning a new plant. New officers have been elected as follows:—Charles Eisler, president and treasurer; Ernest Gamon, Vice President and Engineer.

Barber-Greene Company, Aurora, Ill., manufacturers of ditchers, loaders, conveyors, coal equipment, etc., have recently opened a new office in Cedar Rapids, Iowa, at 527-528 Merchants National Bank Bldg. This office is under the supervision of Jack Marson of the Barber-Greene Company. W. E. Toole opened at the same time a branch office under Marson at 1106 Nicholas St., Omaha, Nebraska.

Brewster-Badeau & Company of 76 William Street, New York City, announce the establishment of a separate toll bridge insurance department to handle the various kinds of insurance carried by their clients owning toll bridges.

The Trackson Company, Milwaukee, Wis., announces the appointment of the Cuyahoga Equipment Company, 5713 Euclid Ave., Cleveland, Ohio, as

Activity Along the Mississippi Despite Weather Conditions



Four draglines working on the Reelfoot Levee, Hickman, Ky. A Bucyrus 115-foot boom, a P. & H., a Northwest and a 1¼-Yard Bucyrus. Elevating grader at work in upper left corner. Work carried on despite snow

When you want catalogs—consult the *classified* INDUSTRIAL LITERATURE section, page 61

distributors of Trackson tractor equipment for McCormick-Deering tractors. The Cleveland territory, which is comprised of nineteen counties in northern Ohia, has been assigned to the Cuyahoga Company, who were also recently appointed distributors for the International Harvester Company's Industrial McCormick-Deering tractors.

The American Hoist & Derrick Co., St. Paul, Minn., manufacturers of hoisting machinery and crawler type shovel cranes, has opened a branch office at 139 Townsend street, San Francisco, Calif.

James S. Watson has been elected Vice President of the Link-Belt Co., with headquarters at the company's Dodge Works in Indianapolis, Ind. For the past 9 years Mr. Watson has been located at the company's Dodge Works in Indianapolis, of which he is General Manager in full charge of the production of Link-Belt Silent and Roller Chain Drives, and from which point he also continues to be responsible for the selling of these drives, as well as Herringbone Speed Reducers.

Itemized Costs of Construction

Resurfacing and Repairing Roadway Areas in Parks

Brooklyn, N. Y.

Items	Quantities	Brooklyn Alcatraz Asphalt Co., 407 Hamilton Ave., Brooklyn. Unit price	Amount	Carbloe Paving Corp., 50 Court St., Brooklyn. Unit price	Amount	Cranford Co., 52 Ninth St., Brooklyn. Unit price	Amount
Cement walks construction..	4,000 sq. ft..	$1.00	$34,000	$1.60	$54,000	$1.15	$39,100
Concrete foundation.....	4,300 cu. yds..	6.60	28,380	6.00	25,800	6.90	29,670
Sewer manholes	40.....	5.00	200	20.00	800	15.00	600
Water gate boxes.....	21.....	5.00	105	20.00	420	15.00	315
Hydrant boxes	13.....	5.00	65	20.00	260	15.00	195
Iron basin head (standard).	49.....	50.00	2,450	70.00	3,430	60.00	2,940
Catch basin reconst.....	15.....170.00		2,550	150.00	2,250	160.00	2,400
Removal of asphalt pave...	34,000 sq. yds..	0.30	10,200	0.25	8,500	0.35	11,900
Removal old conc. found....	25,800 sq. yds..	0.25	6,450	0.01	258	0.10	2,580
Regulating & grading.....	2,000 cu. yds...	0.10	200	1.75	3,500	0.50	1,000
Old curb stones reset.....	700 lin. ft.....	1.50	1,050	2.00	1,400	2.25	1,575
New curb stones.....	700 lin. ft.....	2.40	1,680	3.00	2,100	2.25	1,575
cement walks construction..	4,000 sq. ft.....	0.27	1,080	0.40	1,600	0.31	1,240
Total.....			$88,410		$104,718		$95,090

Sewer Construction

Meade, Kansas.
Contract Awarded Oct. 16.
Cost of trenching and back filling:

No. of ft.	Average depth	Soil	Cost
4,012	0'— 6'	Clay	14c
14,471	6'— 8'	Clay	16c
5,865	8'—10'	Clay	20c
4,650	10'—12'	Clay	25c
1,080	12'—14'	Clay	35c

Cost of laying sewer pipe (not including trenching and backfilling):

No. of ft.	Pipe	Size	Cost
27,728	V. C.	8"	$0.40
5,595	V. C.	10"	.54
4,090	V. C.	12"	.70
50	C. I.	8"	1.50
81	C. I.	10"	2.00
190	C. I.	12"	2.25

Total contract price: $50,924.03.
Contractor: W. B. Carter, Tulsa, Okla.
Information from "Kansas Municipalities."

White River Road, Mt. Ranier National Park

Bureau of Public Roads

Bids opened December 19, 1928

(1) A. C. Goertz, Enunclaw, Wash.; (2) Peck & Einerson, Hoquiam, Wash.; (3) Von der Hellen & Pierson, Medford, Ore.; (4) C. R. Johnson, Portland, Ore.; (5) Lucich & Co., Seattle, Wash.; (6) Frank Fox, Enunclaw, Wash.; (7) Lidral Constr. Co., Seattle, Wash.

Item No.	Item.	Approx Quant.	(1) Unit price	(2) Unit price	(3) Unit price	(4) Unit price	(5) Unit price	(6) Unit price	(7) Unit price
1	Clearing (advance)	8 acres	$1,000.00	$1,000.00	$600.00	$800.00	$1,000.00	$1,200.00	$850.00
2	Grubbing	6 acres	500.00	1,000.00	500.00	800.00	700.00	400.00	500.00
3	Excavation, unclassified	50,000 cu. yds.	.70	.65	.80	.76	.78	.77	.96
6	Excavation, structures	100 cu. yds.	3.00	2.00	2.00	2.00	2.00	2.50	2.50
7	Clearing (completion)	2 acres	500.00	1,000.00	600.00	800.00	600.00	1,500.00	500.00
8	Overhaul	45,000 sta. yds.	.05	.03	.03	.05	.04	.03	.07
10	Finishing	1.35 miles	500.00	250.00	200.00	250.00	200.00	500.00	400.00
29	Timber bumpers	2	20.00	.50	..	25.00	15.00	50.00	100.00
38	Class A concrete	120 cu. yds.	30.00	30.00	30.00	30.00	40.00	30.00	45.00
42	Cement rubble masonry foundation	10 cu. yds.	20.00	15.00	15.00	15.00	12.00	15.00	30.00
43	Reinforcing steel	1,500 lbs.	.10	.10	.08	.10	.10	.10	.10
45	Cem. rubble mas'n'ry ret. & wing wall	25 cu. yds.	20.00	15.00	15.00	15.00	15.00	25.00	30.00
46	Cem. rubble mas'n'ry culvert hdw.	10 cu. yds.	20.00	15.00	15.00	15.00	12.00	35.00	30.00
51	18" corr. galv. metal pipe	530 lin. ft.	3.00	2.25	2.50	2.50	2.50	3.50	2.50
52	24" corr. galv. metal pipe	120 lin. ft.	4.00	3.25	4.50	3.25	4.50	5.00	3.50
61	Hand-laid riprap	50 cu. yds.	5.00	6.00	4.00	1.50	3.00	10.00	6.00
64	6" porous tile drain	200 lin. ft.	1.00	.75	1.00	.75	.50	.50	1.00
66	Wood guard rail	2,000 lin. ft.	.75	.50	.80	1.00	.80	1.00	1.00
67	Stone guard rail	800 lin. ft.	2.00	3.50	4.00	6.00	4.00	3.00	3.00
68	Paved gutters and inlets	10 sq. yds.	2.00	4.00	4.00	4.00	3.00	6.00	5.00
Totals			$60,555.00	$60,686.00	Incomplete	$66,842.50	$67,210.00	$68,265.00	$76,535.00